Engineering and Testing for EMC and Safety Compliance

FCC Part 15 Certification Report

VEGA Grieshaber KG
Am Hohenstein 113
77761 Schiltach
Germany

MODELS: VEGAPULS 61
VEGAPULS 62
VEGAPULS 63

FCC ID: O6QPS60XK1

July 12, 2010

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

Report Prepared By: Desmond A. Fraser

Document Number: 2009282A

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 Part 2, FCC Part 15 and ANSI C63.4.

Signature: ____________________ Date: July 12, 2010

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

These tests are accredited and meet the requirements of ISO/IEC 17025 as verified by ANSI-ASQ National Accreditation Board/ACLASS. Refer to certificate and scope of accreditation AT-1445.

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1 General Information

The following measurement report is prepared on behalf of VEGA Grieshaber KG in accordance with the Federal Communications Commission Rules and Regulations. The Equipment Under Test (EUT) were Models VEGAPULS 61, VEGAPULS 62, and VEGAPULS 63, FCC ID: O6QPS60XK1, Level Probing Radars (LPR) with 10dBm conducted output power for closed tank applications. The configured tanks were metal, concrete and reinforced fiberglass tanks. The EUT also has three housings, aluminum, steel, and plastic. The plastic housing represents the worst-case condition. Hence all data in this FCC report is from the EUT configured using the plastic housing. 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 RTL'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, 2009. 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 VEGAPULS 61/62/63 installed in metal, concrete and reinforced fiberglass tanks.

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., 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 2009).

1.2 Referenced Standards

Standards Referenced for this Report	
Part 2: 2009	Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
Part 15: 2009	Radio frequency devices - §15.209: Radiated Emissions Limits
ANSI C63.4-2009	Standard Format Measurement/Technical Report Personal Computer and Peripherals
Agilent Spectrum Analyzer Application Note	HP Application Note 150-2

2 EUT Configuration, Exercise and Measurement

The test sample was received in November 2009. Listed below are the identifiers and descriptions of equipment, cables, and internal devices used with the EUT for this test, as applicable. The list of antennas is shown in Table 3-1.

The EUT was installed pointing downward inside the closed tanks and configured in constant measurement mode. The VEGAPULS 61/62/63 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 EUT was configured to continuously transmit and receive echoes within the timeframe described above inside closed metal, concrete and fiberglass tanks. The normal operating measurement mode of the EUT is a 0.6ns radar pulse width with 3.56MHz (280ns) pulse repetition frequency.

As a result, all measurements were made with the spectrum analyzer in peak max-hold mode. Since the main lobe of the carrier of the EUT was enclosed in the tanks, FCC measurements requiring 1 MHz RBW's were deemed impractical due to the fact that no radiated emissions were escaping from the closed tanks; the EUT was investigated and measured using 1 kHz, 3 kHz, 10 kHz, and 1 MHz RBWs. No reportable emissions were found; all emissions were at or below the noise floor of the instrumentation, hence the EUT complies with the FCC's limit.

Table 2-1: Equipment Under Test (EUT)

Part	Manufacturer	Model	PN/SN	FCC ID	RTL Bar Code
Pulse Radar Device	VEGA Grieshaber KG	VEGAPULS61/62/63	001	O6QPS60XK1	N/A
Power Supply Cable	VEGA Grieshaber KG	2 wire shielded	001	N/A	N/A

2.1 Test Equipment Consideration

Measurement system dynamic range is typically not sufficient at millimeter frequencies because of high instrument noise floor. As a result, the EUT was investigated by holding the test antenna in and around the closed tanks at different RBWs, namely, 1 MHz, 100 kHz, 10 kHz, 3 kHz, and 1 kHz, in order to find worst-case emissions. When no radiated emissions were detected, the noise floor levels were recorded and reported.

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 are as follows: Metal tank: height 1.2m, diameter 44cm; Concrete tank: height 90cm, diameter 60cm; Reinforced fiber glass tank: height 1.4m, length and width 1m.

3 Pulse De-sensitizing Factor and Duty Cycle

The Pulse width and Pulse period data values provided by the manufacturer are used to calculate the Pulse De-sensitizing Factor (PDF) and the duty cycle. The EUT Pulse width (τ_{eff}) = 0.6 nanosecond; the EUT Pulse period (T) = 280 nanoseconds. The PDF is used to calculate the FCC's peak limit, which is 20 dB above the average limit, when emissions from the carrier can be measured. Since there were no emissions found, the PDF was not used.

3.1 Calculation of Pulse Desensitization Factor

As described in the Agilent Application Note 150-2, "Spectrum Analysis...Pulsed RF", there are two possible Pulse Desensitization Factors (PDF) depending on whether the EUT is configured in line or in spectrum mode.

3.1.1 Line Spectrum Mode

The PDF can be calculated using

$$RBW < 0.3 * PRF \qquad \text{(equ.1)}$$

$$PDF = 20 * \log\left(\frac{\tau_{eff}}{T}\right) = 20 * \log(\tau_{eff} * PRF) \qquad \text{(equ.2)}$$

Where $\tau_{eff:}$ Effective Pulse Length

PRF: Pulse Repetition Frequency

3.1.2 Pulse Spectrum Mode

For the PDF value in Pulse Spectrum Mode, the resolution bandwidth (RBW) of the analyzer shall be:

$$RBW > 1.7 * PRF \qquad \text{(equ.3) and}$$

$$RBW < \frac{0.1}{\tau_{eff}} \qquad \text{(equ.4)}$$

In this instance, the PDF can be calculated as:

$$PDF = 20 * \log(\tau_{eff} * K * RBW) \qquad \text{(equ.5)}$$

Where, K correction factor for the IF amplifier of the spectrum analyzer (in case of an Agilent PSA-model K) = 1.5

3.1.3 Duty Cycle Factor

The Duty Cycle Factor is used to calculate the final FCC average limit by subtracting the Duty Cycle Factor (DCF) from the Peak result.

Where $DCF = 20 * \log\left(\frac{\tau_{eff}}{T}\right) = 20 * \log(\tau_{eff} * PRF)$ (equ.6)

Where: $\tau_{eff:}$ [Pulse width], T [Pulse Repetition Period], PRF [Pulse Repetition Frequency]

DCF = 20*LOG (0.6ns/280ns) = 53.4dB

3.2 Field Strength Calculation

The final peak and average field strength was calculated using the following:

Peak result = Spectrum Analyzer Level (dBµV/m) + CF (dB/m) + SCF (dB)

Average result = Spectrum Analyzer Level (dBµV) + CF (dB/m) + SCF (dB) - DCF (dB)

Pulse De-sensitizing Factor (PDF) = Pulse width/Pulse period = 20Log 0.6nS/280nS = 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 Pulse spectrum] = 53.4dB

SCF = 8.3dB

3.3 EUT Antenna Data

Table 3-1: EUT Antenna Data

Antenna Type	Gain (dBi)	Antennas Tested
245mm Parabolic Horn	33.0	X
95mm Horn	27.4	X
75mm Horn	24.5	Note 1
50mm Horn	21.5	Note 1
40mm Horn	20.0	X
75mm Metal Horn	22.0	X
48mm Metal Horn	19.6	X
80mm Plastic Horn	24.8	X
½” Stub	20.3	X
½” Stand Pipe	-	X

Note 1: These two antennas (75mm and 50mm Horn) were not tested but they belong to the same family of antennas as the 40mm and 95mm horn antennas. The FCC allows the highest and the lowest gain antennas within the same antenna family; namely, the 40mm and 95mm horn antennas, to represent the antenna family when tested.

3.4 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. The EUT was also investigated at closer test distances in order to discern any emissions.

3.5 Test Set-up

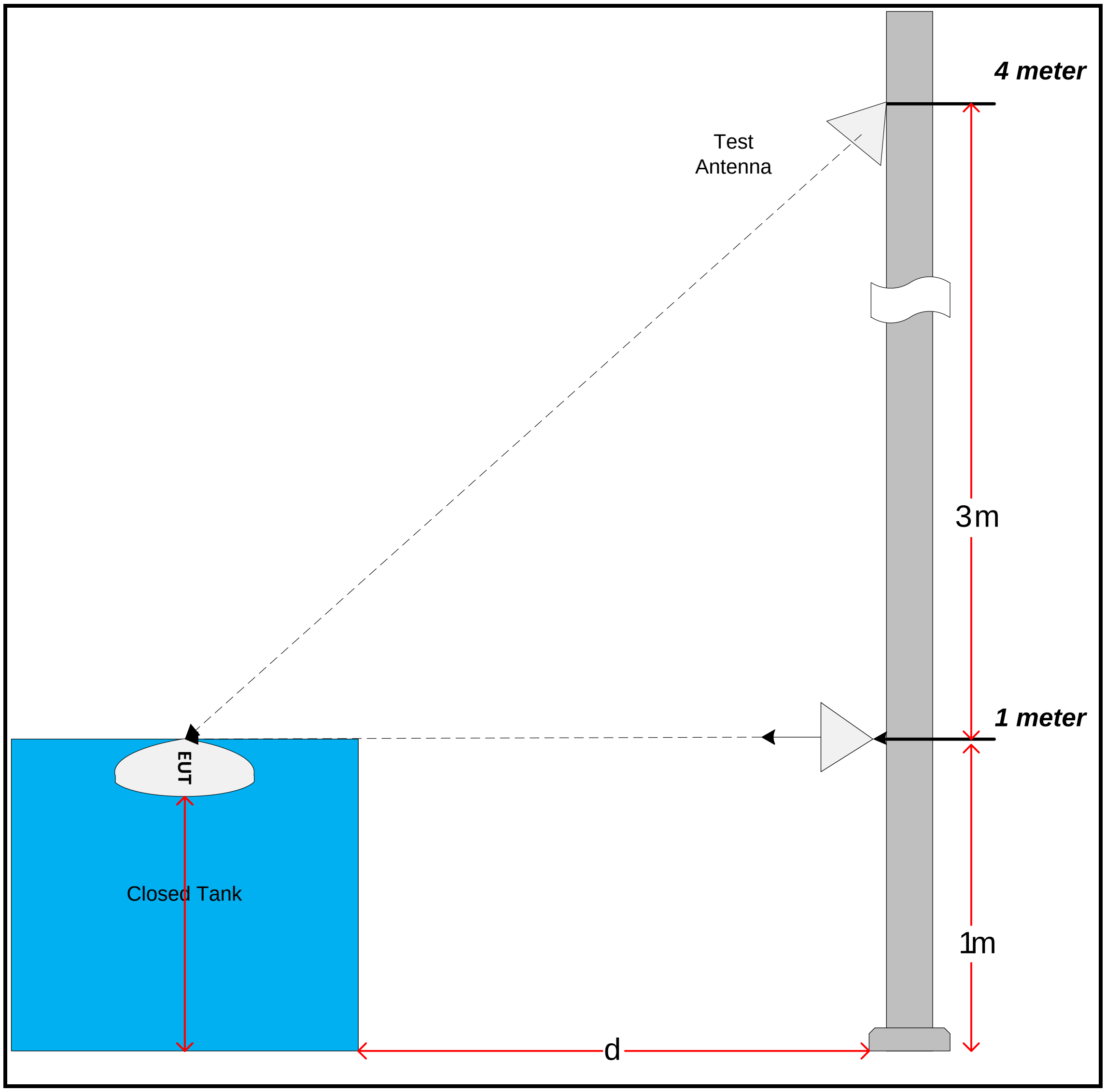


Figure 3-1: Radiated Emissions Test Set-up

4 Conducted Emissions - §15.207

4.1 Conducted Limits - §15.207 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 three housings - plastic, aluminum, and steel; there was no difference in the conducted emissions data for the three housings. The data below is the worst-case conducted emissions measured using the EUT with plastic housing and the highest gain antenna, the 33dBi parabolic antenna.

4.2 Conducted Emission Limits Test Data

Table 4-1: Conducted Emissions Limits - Neutral Side (Line 1)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	FCC QP Limit (dBuV)	FCC QP Margin (dBuV)	FCC AV Limit (dBuV)	FCC AV Margin (dBuV)	Pass/ Fail
0.216	Pk	27.5	0.2	27.7	63.0	-35.3	53.0	-25.3	Pass
0.286	Pk	27.8	0.2	28.0	60.6	-32.6	50.6	-22.6	Pass
0.356	Pk	25.7	0.2	25.9	58.8	-32.9	48.8	-22.9	Pass
4.040	Pk	41.2	1.0	42.2	56.0	-13.8	46.0	-3.8	Pass
15.840	Pk	36.7	2.2	38.9	60.0	-21.1	50.0	-11.1	Pass
22.260	Pk	31.7	2.5	34.2	60.0	-25.8	50.0	-15.8	Pass

Table 4-2: Conducted Emissions Limits – Hot Side (Line 2)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	FCC QP Limit (dBuV)	FCC QP Margin (dBuV)	FCC AV Limit (dBuV)	FCC AV Margin (dBuV)	Pass/ Fail
0.212	Pk	29.4	0.2	29.6	63.1	-33.5	53.1	-23.5	Pass
0.284	Pk	22.9	0.2	23.1	60.7	-37.6	50.7	-27.6	Pass
0.356	Pk	26.3	0.2	26.5	58.8	-32.3	48.8	-22.3	Pass
0.568	Pk	17.3	0.2	17.5	56.0	-38.5	46.0	-28.5	Pass
3.890	Pk	41.9	1.0	42.9	56.0	-13.1	46.0	-3.1	Pass
15.860	Pk	33.5	2.2	35.7	60.0	-24.3	50.0	-14.3	Pass
21.320	Pk	29.3	2.4	31.7	60.0	-28.3	50.0	-18.3	Pass

Test Personnel:

Desmond A. Fraser
EMC Test Engineer

Signature

06/18/2010
Date of Test

5 Radiated Emissions - §15.209

5.1 Radiated Emission Limits - §15.209 – 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 FCC Millimeter Wave Procedure and ANSI 63.4, 2009 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. Each tank was 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 was 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.

The EUT was investigated and tested with three housings - plastic, aluminum, and steel; there was no difference in the radiated emissions data for the three housings. The data below is the worst-case radiated emissions measured using the EUT with plastic housing and the antennas listed in the radiated emissions data Tables 5-1, 5-2, and 5-3.

5.2 Radiated Emissions 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 metal, concrete or fiberglass tank configurations. Furthermore, the noise floor levels were the same whether the EUT was operating or was off.

No other emissions above the system noise floor were detected for the EUT with different antennas in the metal, concrete or reinforced fiberglass tank configurations. The following plots are the measured analyzer noise floor level of the EUT operating in metal, concrete and reinforced fiberglass tanks. As stated in Section 2.2, the EUT was investigated by holding the test antenna in and around the closed tanks using different RBWs to find and detect any radiated emissions. No emissions were found in the three tank configurations using the antennas listed.

5.2.1 Metal Tank Test Data

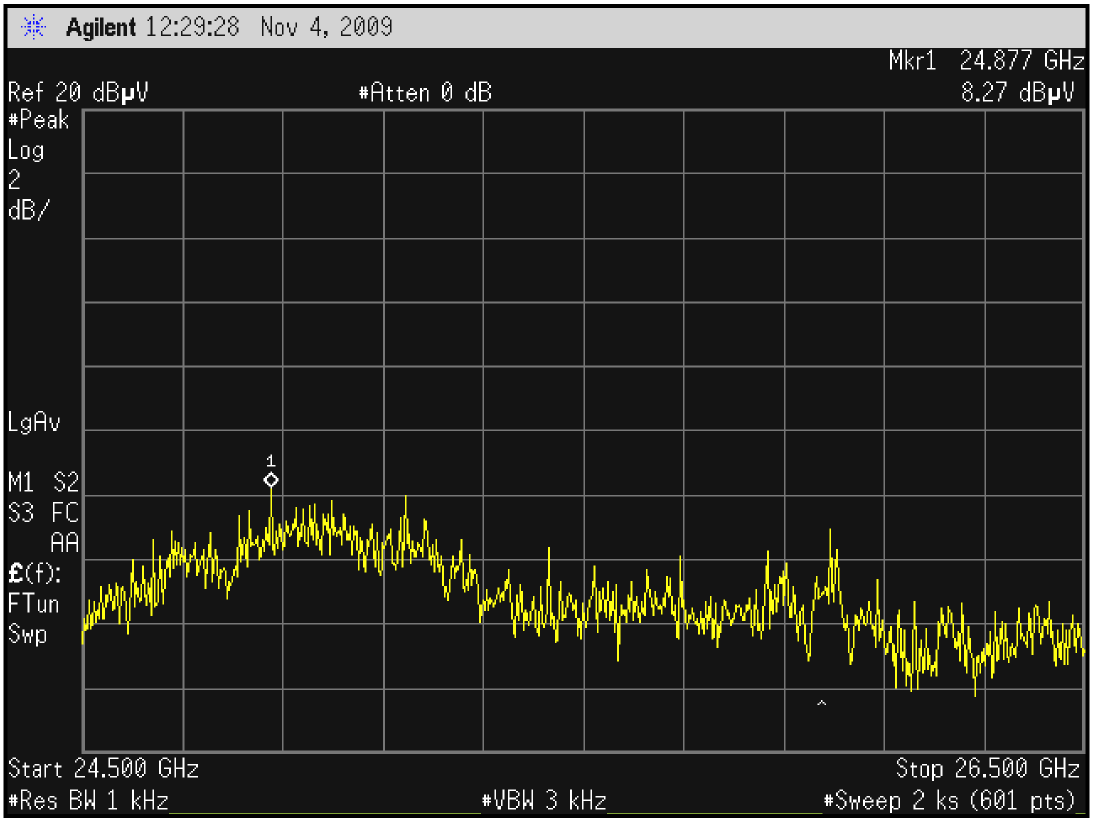
Table 5-1: Field Strength of Carrier in Metal Tank

Antenna Type	Detector	Antenna Pol. (H/V)	Frequency (GHz)	Spectrum Analyzer Level (dBµV)	Site Correction Factor (dBµV/m)	PDCF (dB) Note 1	Spectrum Analyzer Level Corrected (dBµV/m)	Duty Cycle Factor (dB)	Spectrum Analyzer Level Final (dBµV/m)	FCC Limit (dBµV)	Margin (dB)	Note 2 [See Plot]
245-mm Parabolic Horn	Peak	H/V	24.877	8.27	8.3	N/A	16.57	N/A	16.57	74.0	-57.4	Plot 5-1
95-mm Horn	Peak	H/V	25.003	9.54	8.3	N/A	17.83	N/A	17.83	74.0	-56.2	Plot 5-2
40-mm Horn	Peak	H/V	24.957	9.13	8.3	N/A	17.43	N/A	17.43	74.0	-56.6	Plot 5-3
75-mm Metal Horn	Peak	H/V	24.860	8.92	8.3	N/A	17.22	N/A	17.22	74.0	-56.8	Plot 5-4
48-mm Metal Horn	Peak	H/V	24.907	8.33	8.3	N/A	16.63	N/A	16.63	74.0	-57.4	Plot 5-5
80-mm Plastic Horn	Peak	H/V	25.887	8.10	8.3	N/A	16.4	N/A	16.4	74.0	-57.6	Plot 5-6
½" Stub	Peak	H/V	24.892	8.02	8.3	N/A	16.32	N/A	16.32	74.0	-57.7	Plot 5-7
½" Standpipe	Peak	H/V	24.787	7.69	8.3	N/A	17.99	N/A	17.99	74.0	-56.0	Plot 5-8

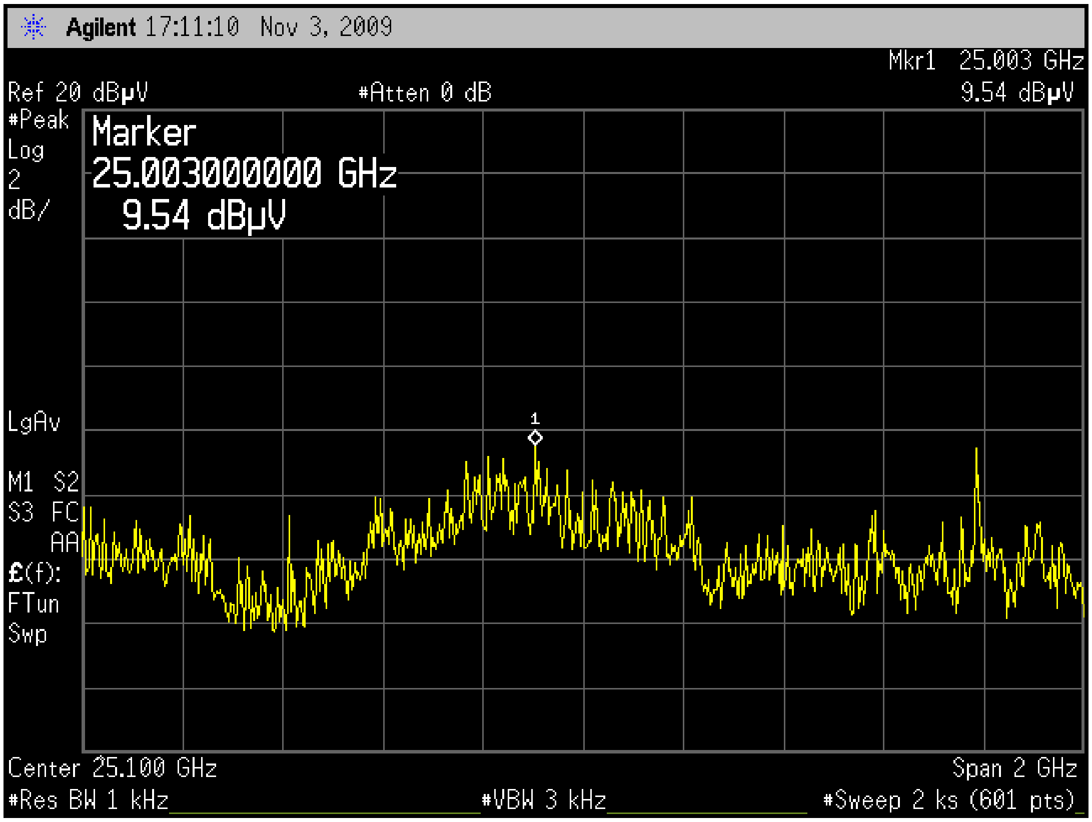
Note 1: The carrier and all other emissions are completely attenuated by the tank; there are no spurious emissions to be measured. However, noise floor measurements were investigated from 1 MHz to 1 kHz. The data in these plots represents the noise floor at 1 kHz.

Note 2: Though it is typical to demonstrate compliance using at least six data points, noise floor Plots 5-1 to 5-8 are used to demonstrate compliance.

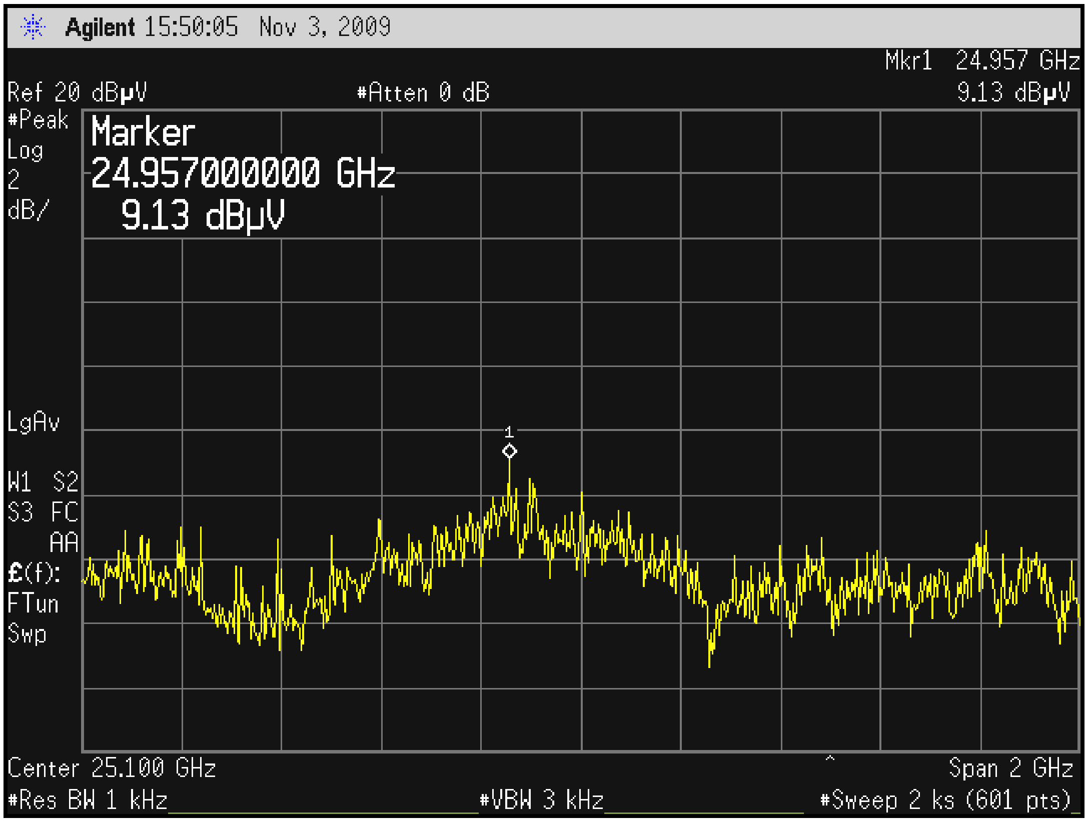
Plot 5-1: **Analyzer Noise Floor Level - EUT [245-mm Horn Antenna] in Metal Tank**



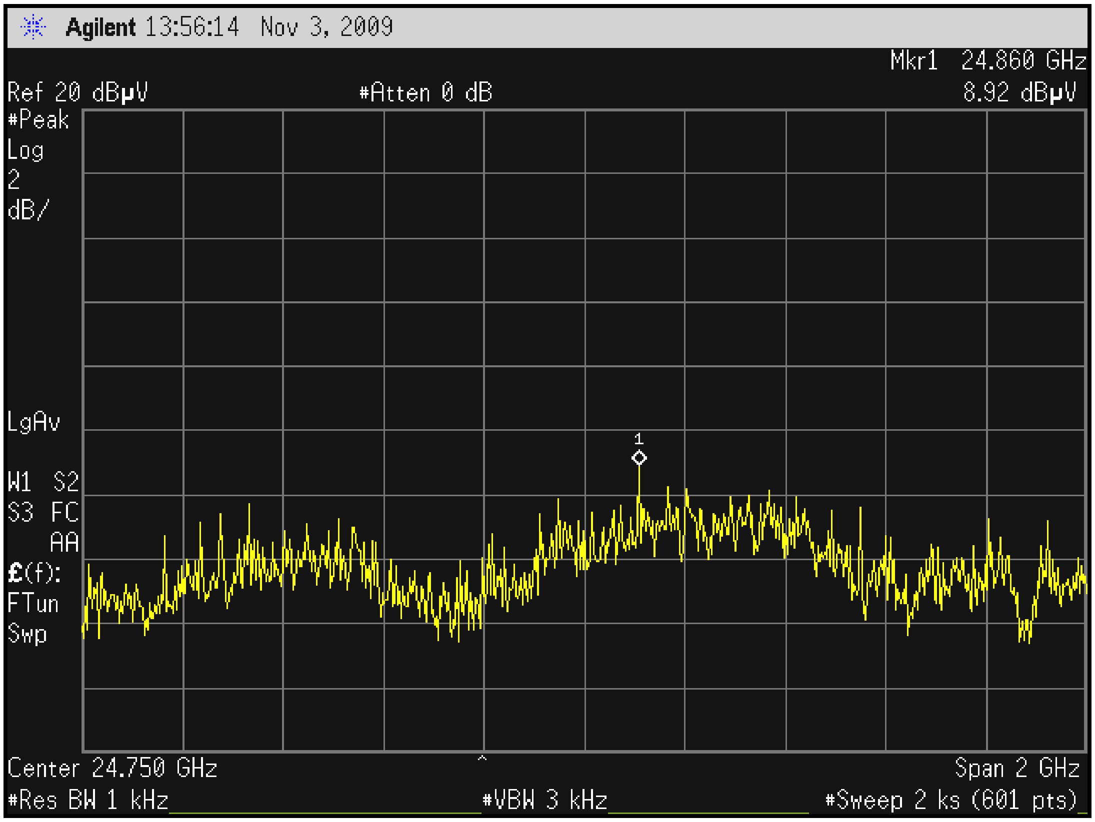
Plot 5-2: Analyzer Noise Floor Level - EUT [95-mm Horn Antenna] in Metal Tank



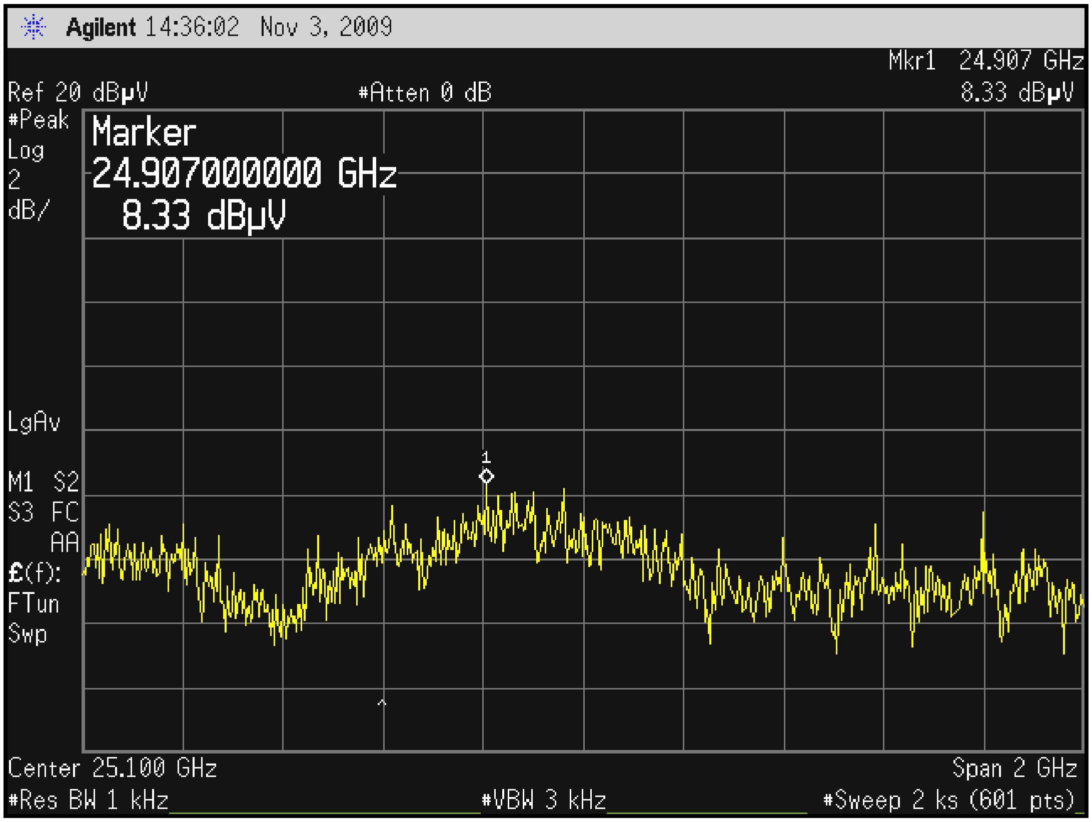
Plot 5-3: Analyzer Noise Floor Level - EUT [40-mm Horn Antenna] in Metal Tank



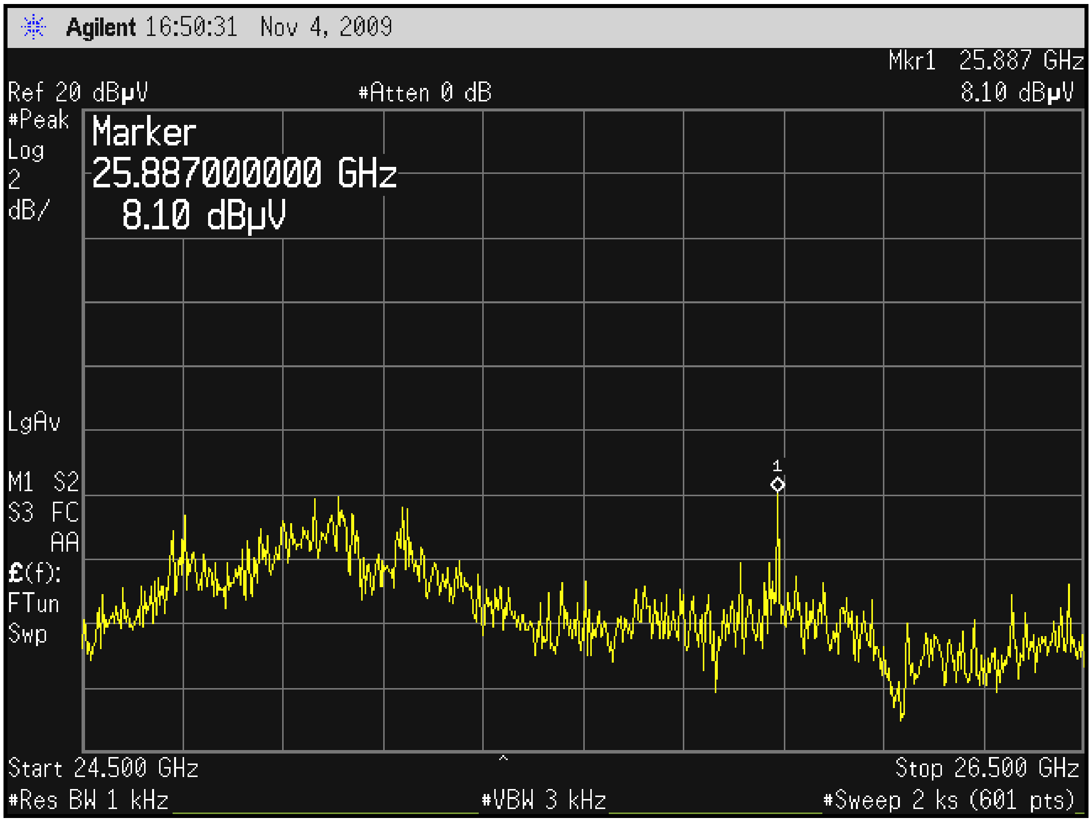
Plot 5-4: Analyzer Noise Floor Level - EUT [75-mm Metal Antenna] in Metal Tank



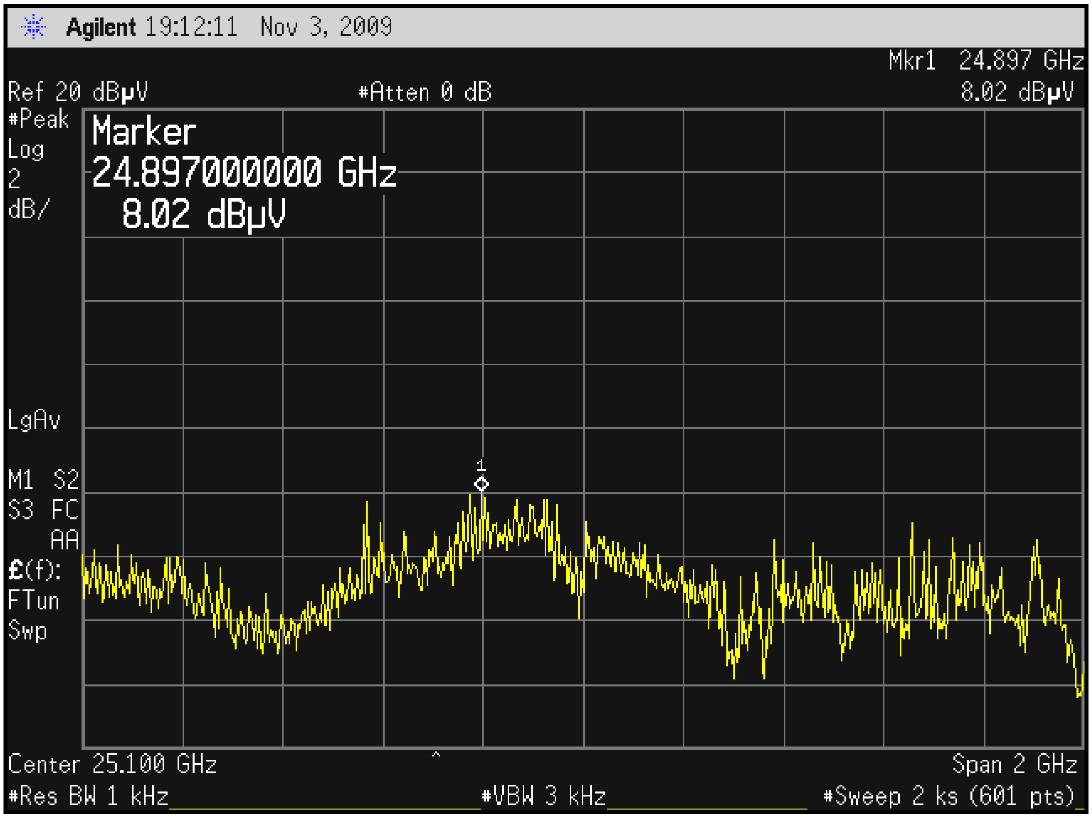
Plot 5-5: **Analyzer Noise Floor Level - EUT [48-mm Metal Antenna] in Metal Tank**



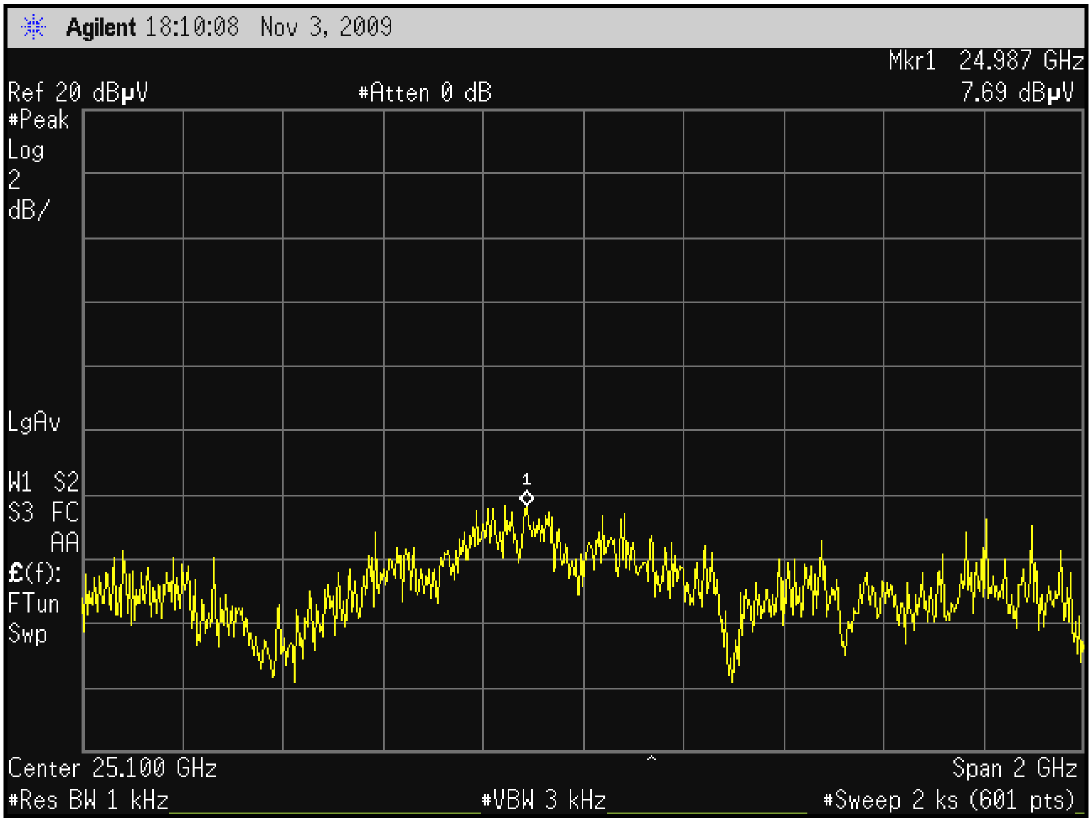
Plot 5-6: Analyzer Noise Floor Level - EUT [80-mm Plastic Antenna] in Metal Tank



Plot 5-7: **Analyzer Noise Floor Level - EUT [1/2" Stub Antenna] in Metal Tank**



Plot 5-8: Analyzer Noise Floor Level EUT [1/2" Standpipe Antenna] in Metal Tank



Test Personnel:

Desmond A. Fraser
EMC Test Engineer

Signature

November 3, 2009
Date of Test

5.2.2 Concrete Tank Test Data

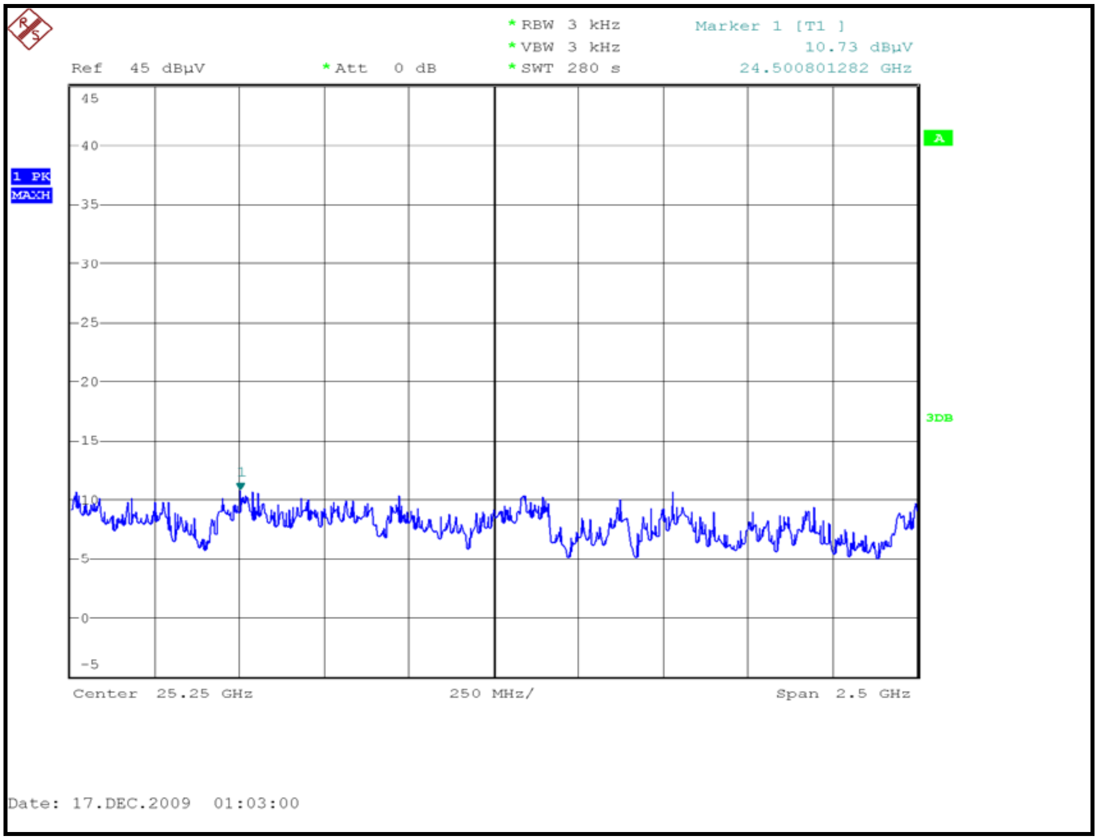
Table 5-2: Field Strength of Carrier with Concrete Tanks

Antenna Type	Detector	Antenna Pol. (H/V)	Frequency (GHz)	Spectrum Analyzer Level (dBµV)	Site Correction Factor (dBµV/m)	PDCF (dB) Note 1	Spectrum Analyzer Level Corrected (dBµV/m)	Duty Cycle Factor (dB)	Spectrum Analyzer Level Final (dBµV/m)	FCC Limit (dBµV)	Margin (dB)	Note 2 [See Plot]
245-mm Parabolic Horn	Peak	H/V	24.500	10.73	8.3	N/A	19.0	N/A	19.0	74.0	-55.0	Plot 5-9
95-mm Horn	Peak	H/V	25.366	11.83	8.3	N/A	20.1	N/A	20.1	74.0	-53.9	Plot 5-10
40-mm Horn	Peak	H/V	25.346	11.07	8.3	N/A	19.4	N/A	19.4	74.0	-54.6	Plot 5-11
75-mm Metal Horn	Peak	H/V	24.524	11.10	8.3	N/A	19.4	N/A	19.4	74.0	-54.6	Plot 5-12
48-mm Metal Horn	Peak	H/V	25.818	11.21	8.3	N/A	19.5	N/A	19.5	74.0	-54.5	Plot 5-13
80-mm Plastic Horn	Peak	H/V	25.362	9.10	8.3	N/A	17.4	N/A	17.4	74.0	-56.6	Plot 5-14
½” Stub	Peak	H/V	25.897	10.91	8.3	N/A	19.2	N/A	19.2	74.0	-54.8	Plot5-14
½” Standpipe	Peak	H/V	25.228	10.94	8.3	N/A	19.2	N/A	19.2	74.0	-54.8	Plot 5-16

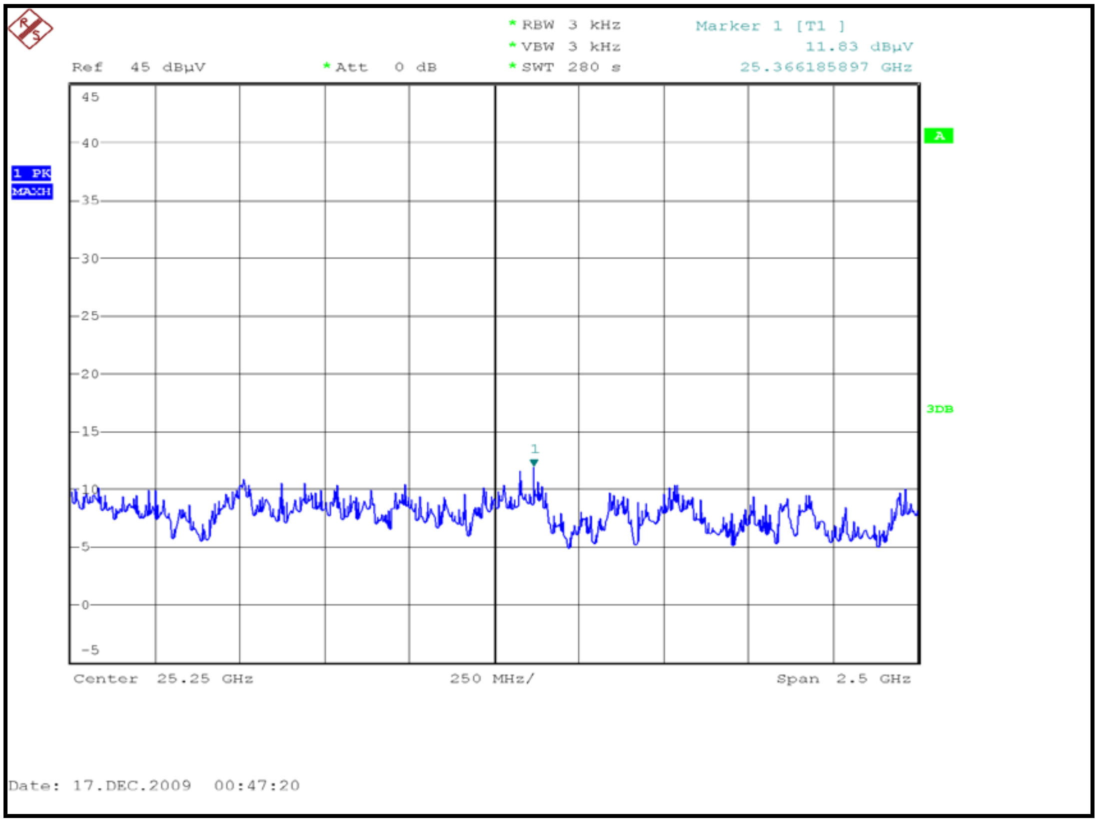
Note 1: The carrier and all other emissions are completely attenuated by the tank; there are no spurious emissions to be measured. However, noise floor measurements were investigated from 1 MHz to 3 kHz. The data in these plots represents the noise floor at 3 kHz.

Note 2: Though it is typical to demonstrate compliance using at least six data points, noise floor Plots 5-9 to 5-16 are used to demonstrate compliance.

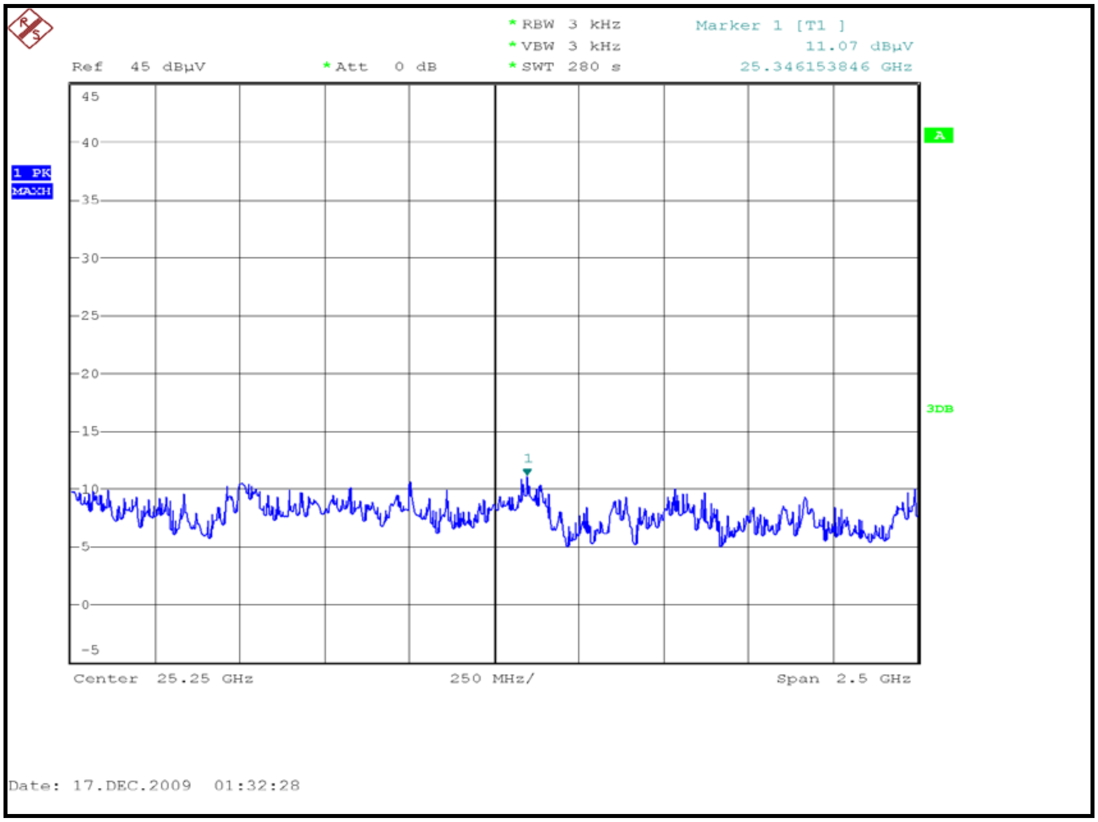
Plot 5-9: Analyzer Noise Floor Level - EUT [245-mm Horn Antenna] in Concrete Tank



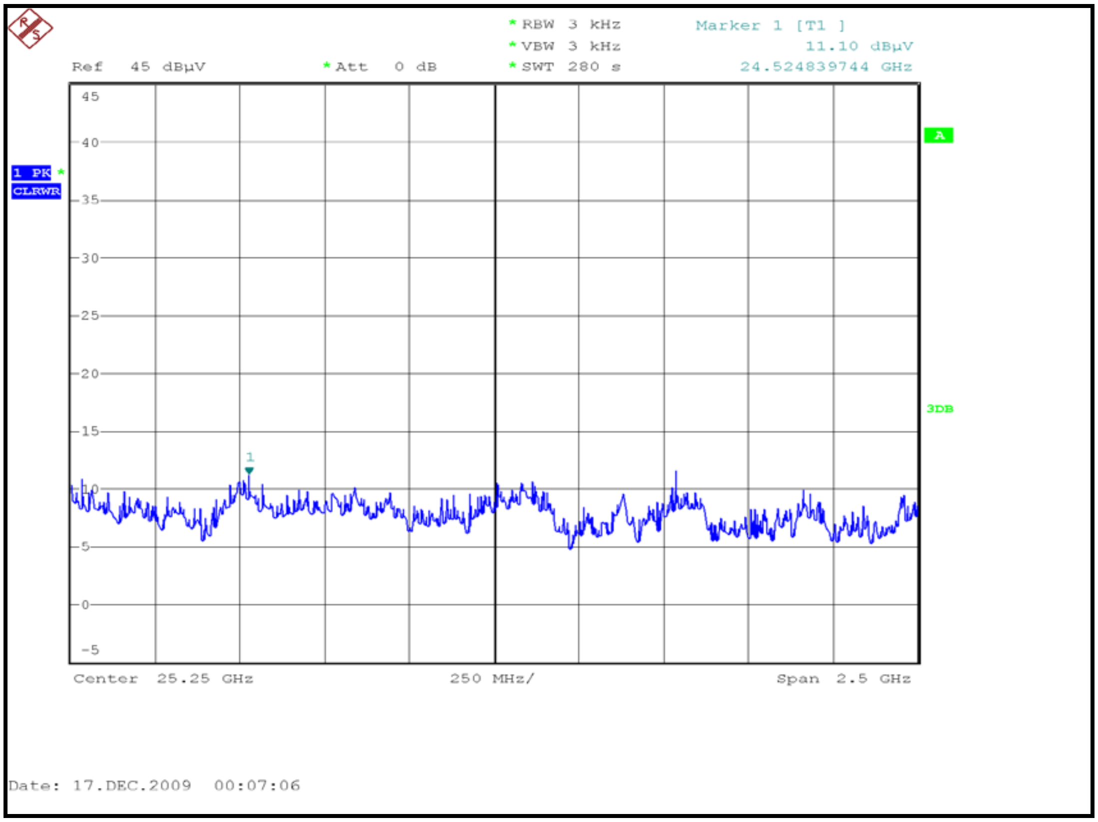
Plot 5-10: Analyzer Noise Floor Level – EUT [95-mm Horn Antenna in Concrete Tank



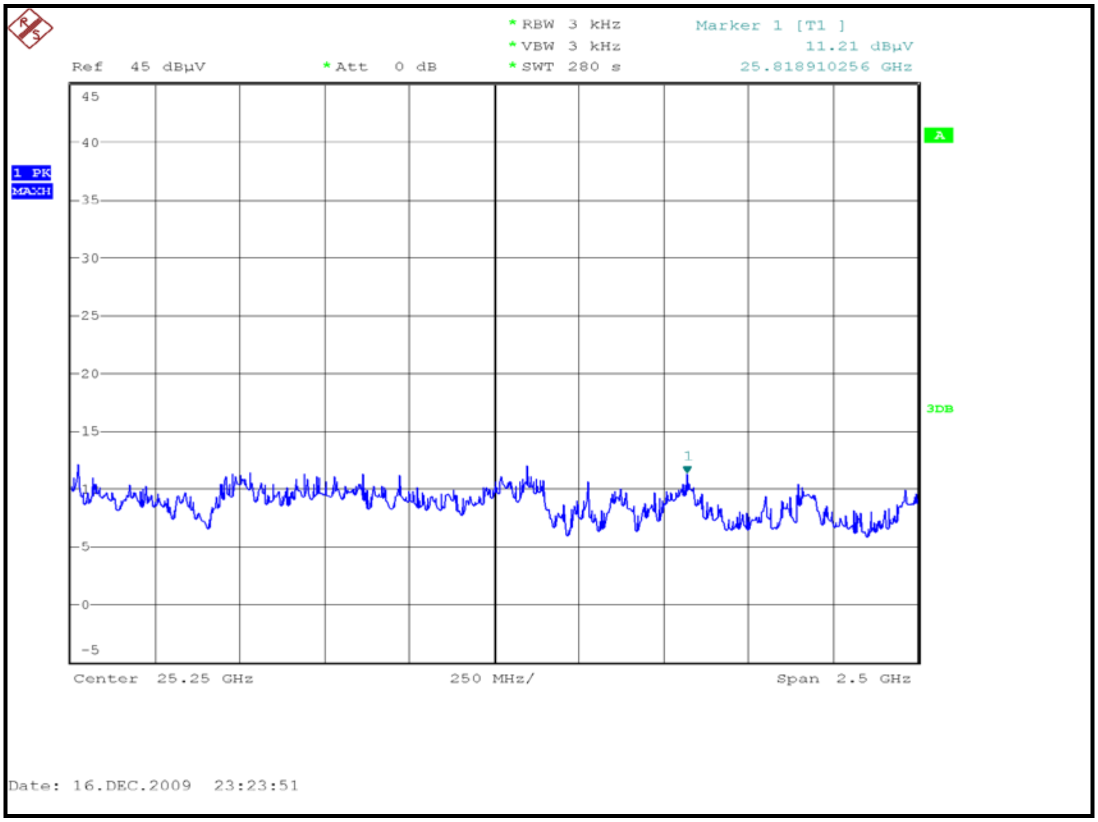
Plot 5-11: Analyzer Noise Floor Level - EUT [40-mm Horn Antenna] in Concrete Tank



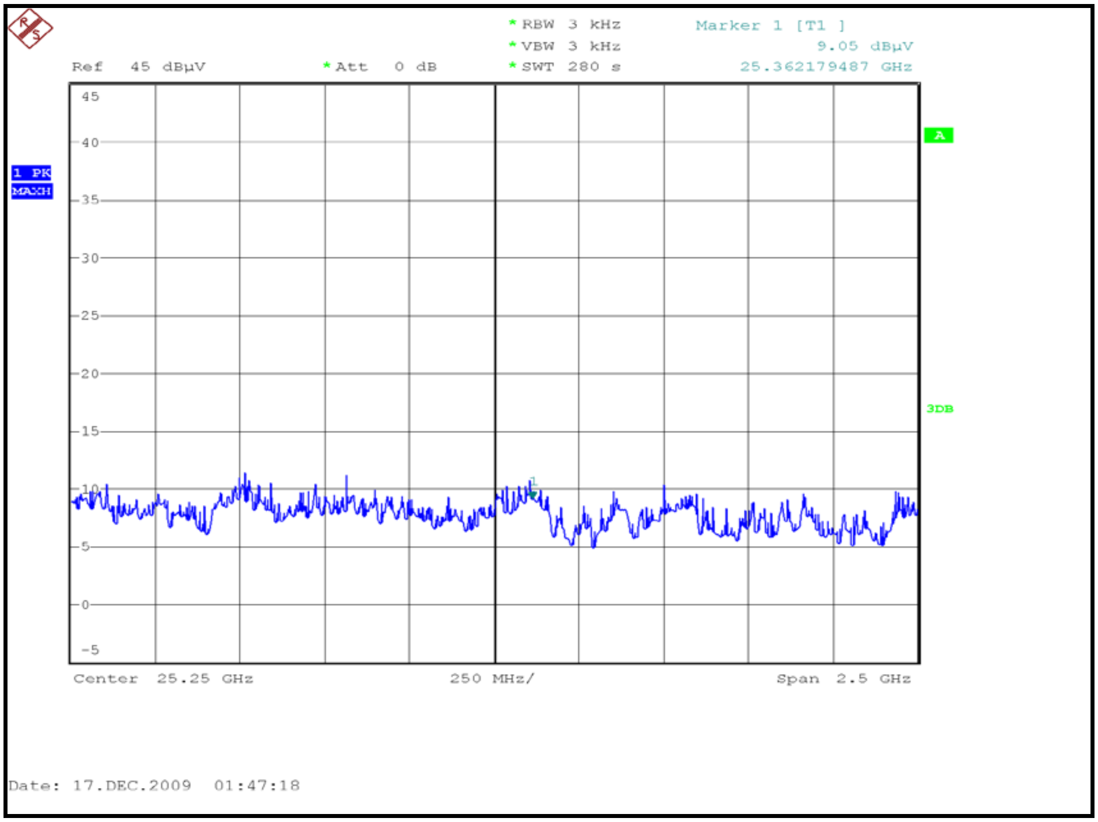
Plot 5-12: Analyzer Noise Floor Level - EUT [75-mm Metal Antenna] in Concrete Tank



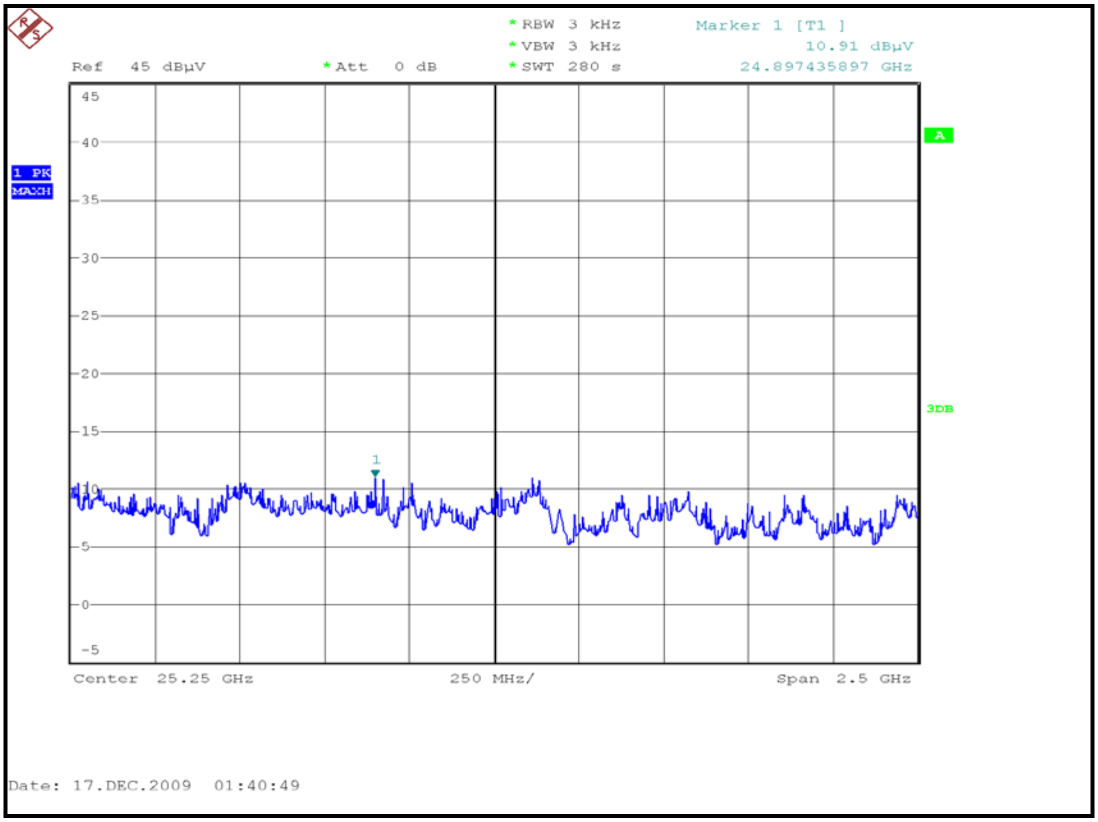
Plot 5-13: Analyzer Noise Floor Level - EUT [48-mm Metal Antenna] in Concrete Tank



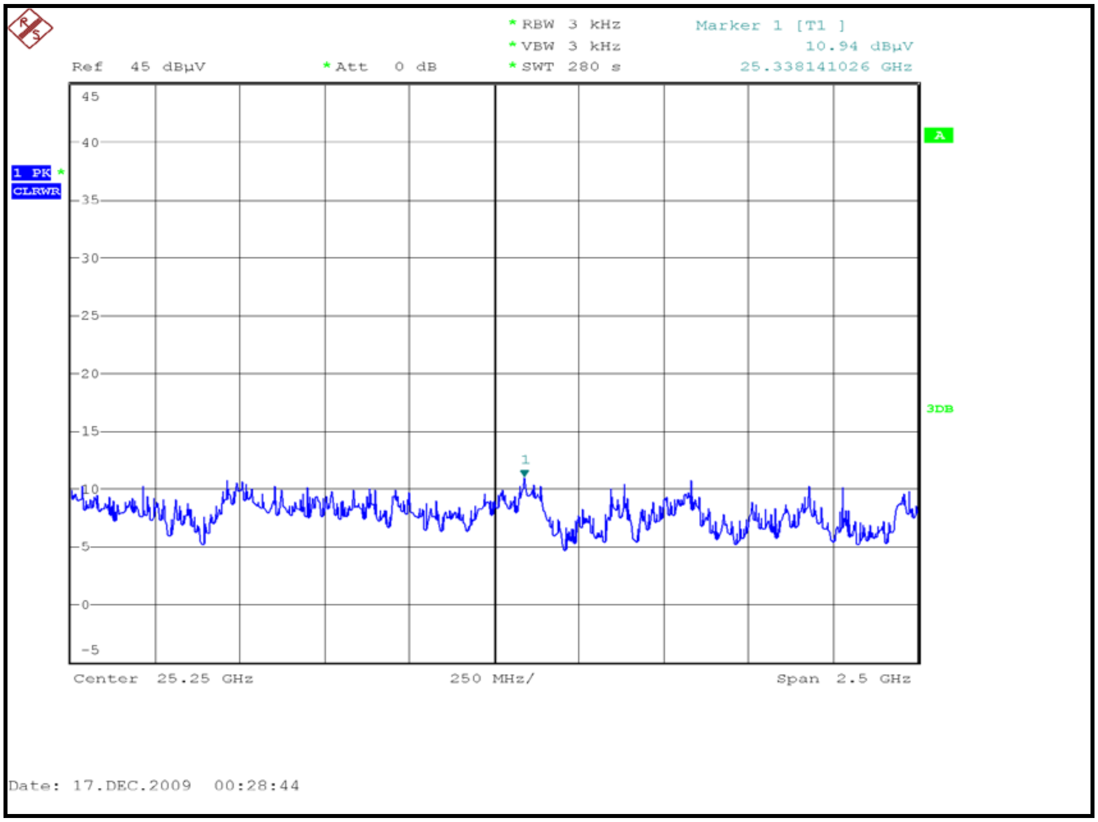
Plot 5-14: Analyzer Noise Floor Level - EUT [80-mm Plastic Antenna] in Concrete Tank



Plot 5-15: Analyzer Noise Floor Level - EUT [1/2" Stub Antenna] in Concrete Tank



Plot 5-16: Analyzer Noise Floor Level - EUT [1/2" Standpipe Antenna] in Concrete Tank



Test Personnel:

Desmond A. Fraser	[signature]	December 17, 2009
EMC Test Engineer	Signature	Date of Test

5.2.3 Fiberglass Tank Test Data

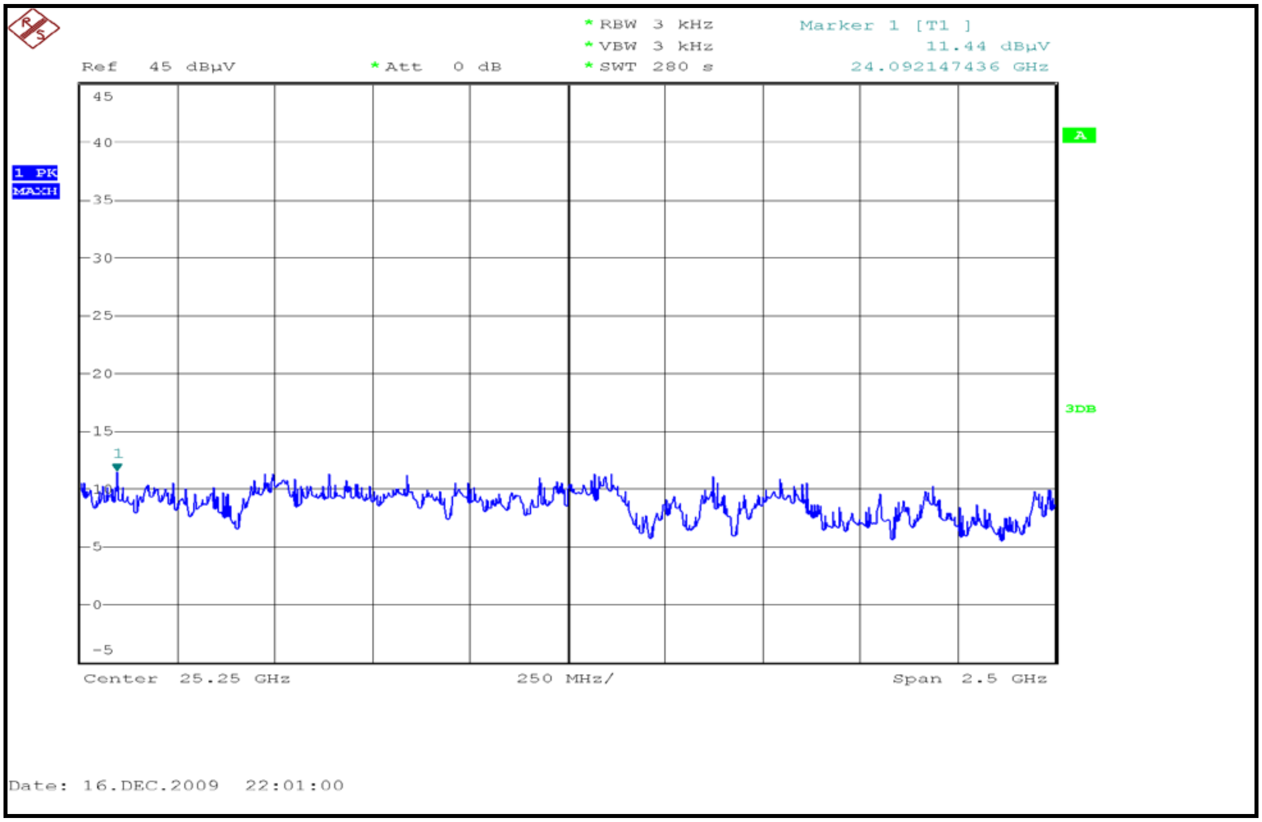
Table 5-3: Field Strength of Carrier with Fiberglass Tank

Antenna Type	Detector	Antenna Pol. (H/V)	Frequency (GHz)	Spectrum Analyzer Level (dBµV)	Site Correction Factor (dBµV/m)	PDCF (dB) Note 1	Spectrum Analyzer Level Corrected (dBµV/m)	Duty Cycle Factor (dB)	Spectrum Analyzer Level Final (dBµV/m)	FCC Limit (dBµV)	Margin (dB)	Note 2 [See Plot]
245-mm Parabolic Horn	Peak	H/V	24.092	11.44	8.3	N/A	19.7	N/A	19.7	74.0	-54.3	Plot 5-17
95-mm Horn	Peak	H/V	24.192	11.08	8.3	N/A	19.4	N/A	19.4	74.0	-54.6	Plot 5-18
40-mm Horn	Peak	H/V	24.732	11.13	8.3	N/A	19.4	N/A	19.4	74.0	-54.6	Plot 5-19
75-mm Metal Horn	Peak	H/V	24.516	11.12	8.3	N/A	19.4	N/A	19.4	74.0	-54.6	Plot 5-20
48-mm Metal Horn	Peak	H/V	24.733	11.38	8.3	N/A	19.7	N/A	19.7	74.0	-54.3	Plot 5-21
80-mm Plastic Horn	Peak	H/V	24.957	11.56	8.3	N/A	19.9	N/A	19.9	74.0	-54.1	Plot 5-22
½" Stub	Peak	H/V	24.460	11.06	8.3	N/A	19.4	N/A	19.4	74.0	-54.6	Plot 5-23
½" Standpipe	Peak	H/V	25.266	11.77	8.3	N/A	20.1	N/A	20.1	74.0	-53.9	Plot 5-24

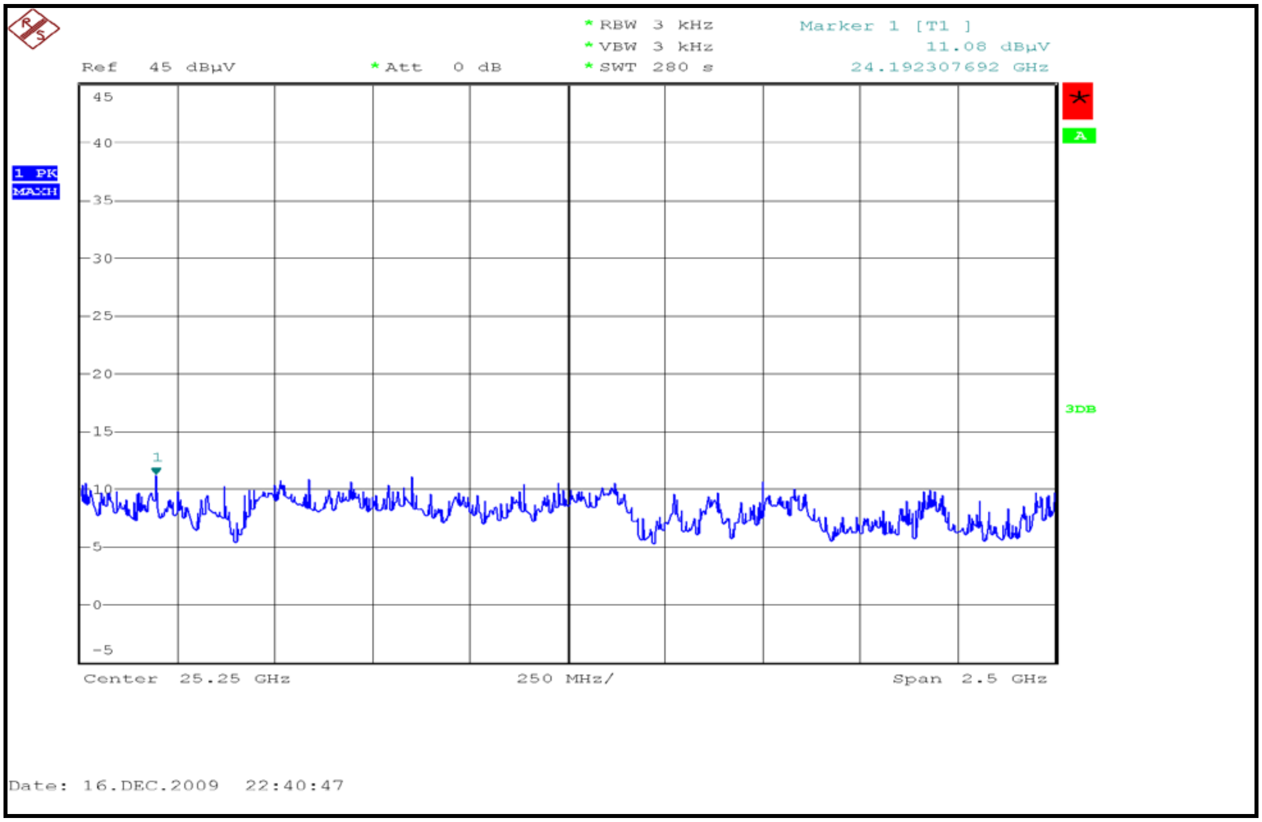
Note 1: The carrier and all other emissions are completely attenuated by the tank; there are no spurious emissions to be measured. However, noise floor measurements were investigated from 1 MHz to 1 kHz. The data in these plots represents the noise floor at 1 kHz.

Note 2: Though it is typical to demonstrate compliance using at least six data points, noise floor Plots 5-17 to 5-24 are used to demonstrate compliance.

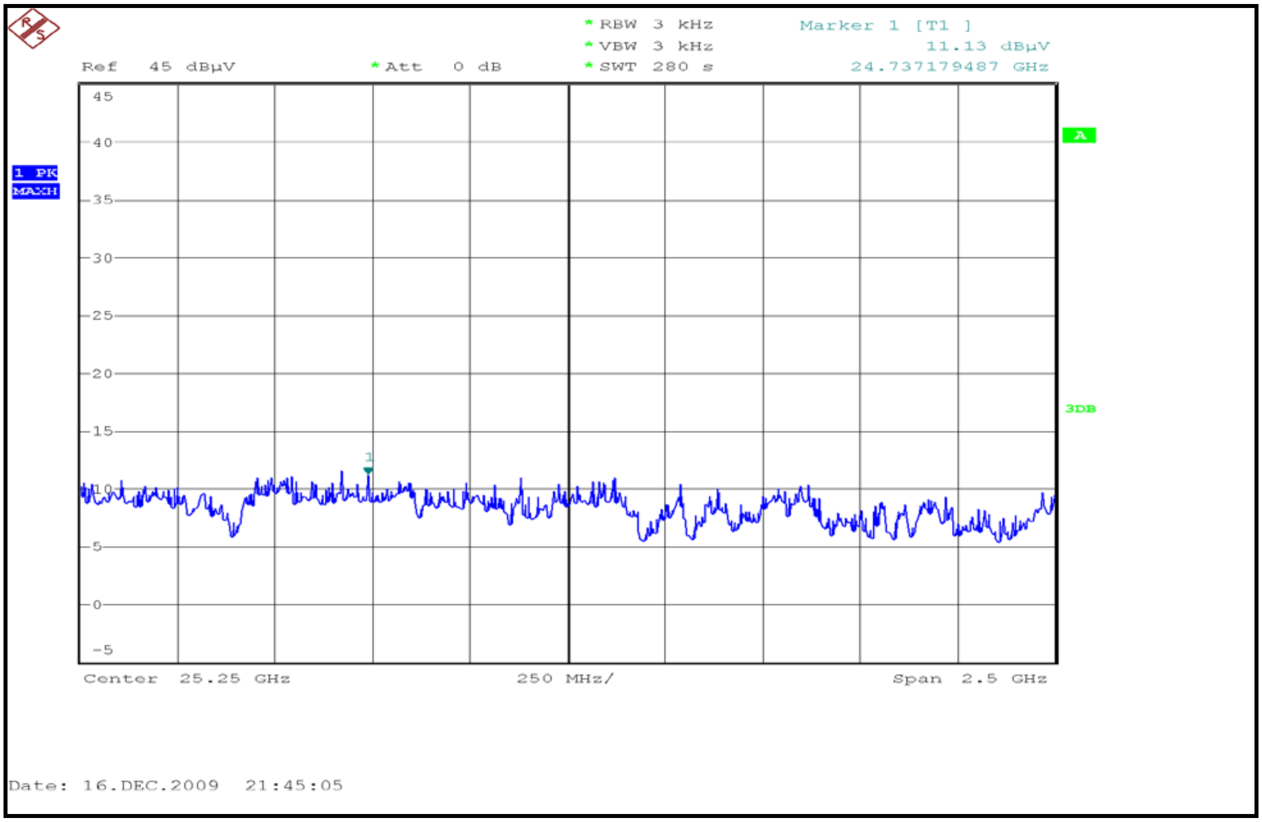
Plot 5-17: Analyzer Noise Floor Level - EUT [245-mm Horn Antenna] in Fiberglass Tank



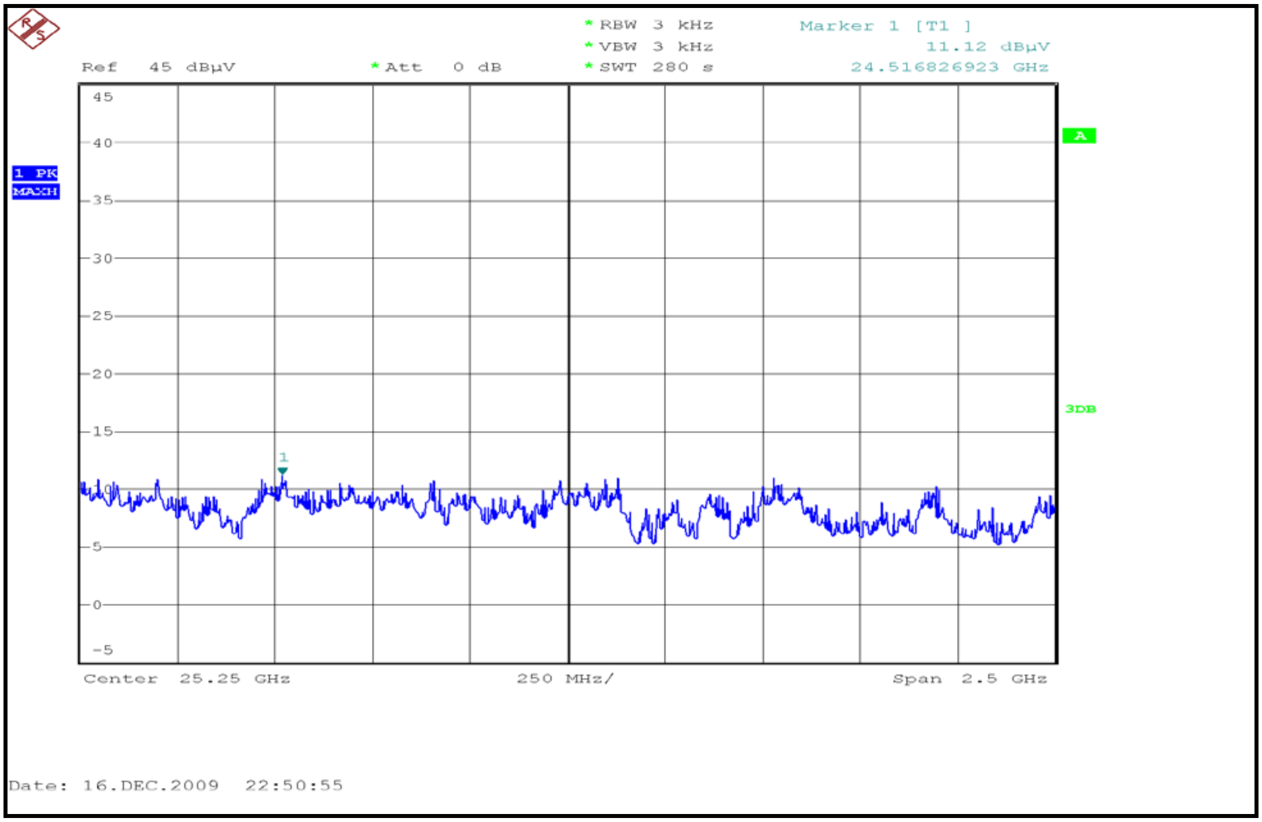
Plot 5-18: Analyzer Noise Floor Level - EUT [95-mm Horn Antenna] in Fiberglass Tank



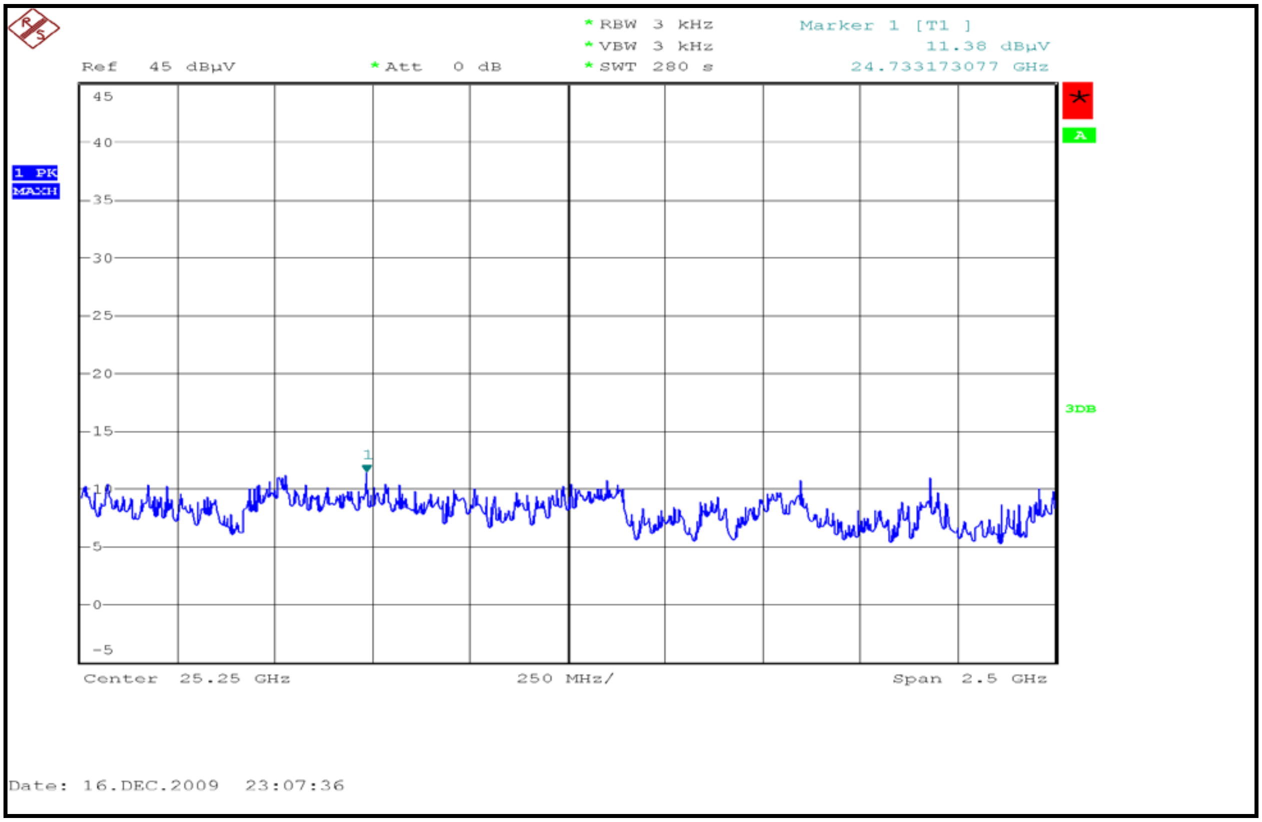
Plot 5-19: Analyzer Noise Floor Level - EUT [40-mm Horn Antenna] in Fiberglass Tank



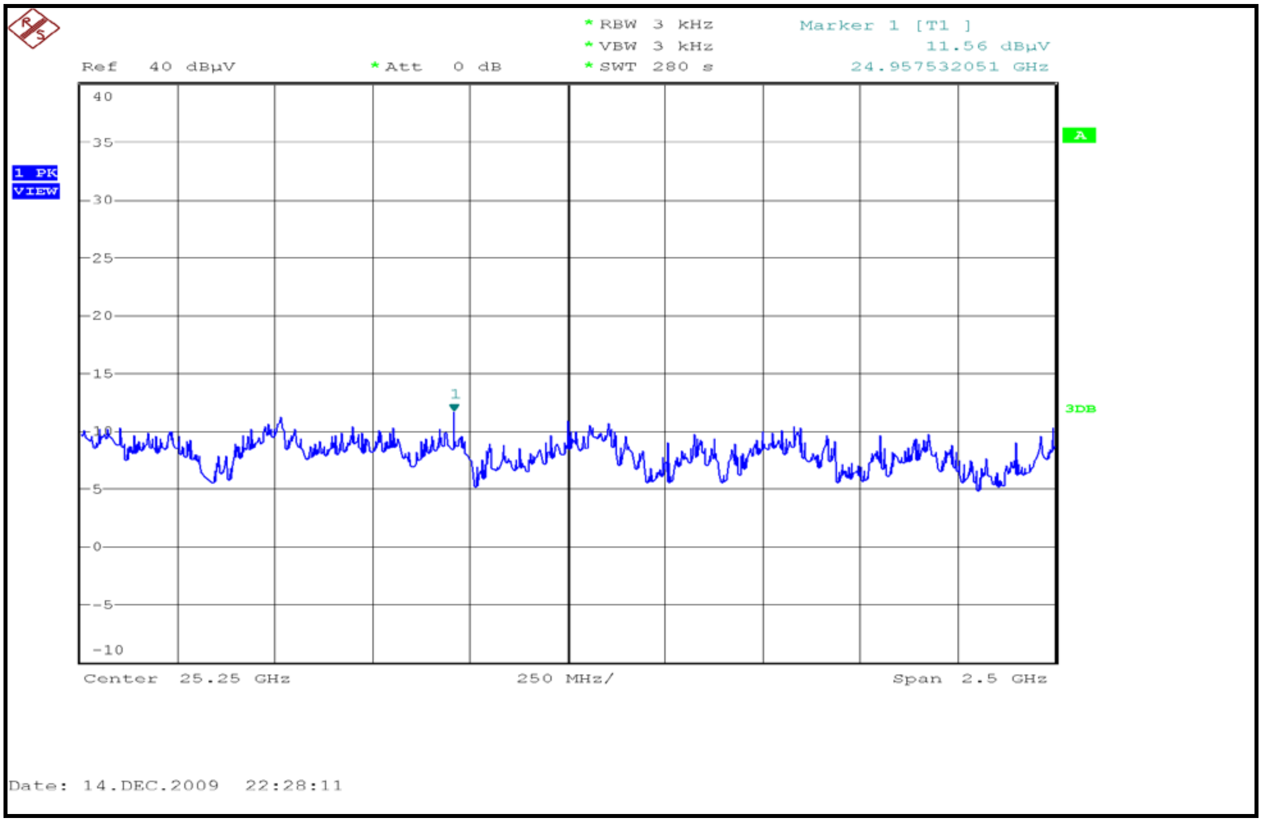
Plot 5-20: Analyzer Noise Floor Level - EUT [75-mm Metal Antenna] in Fiberglass Tank



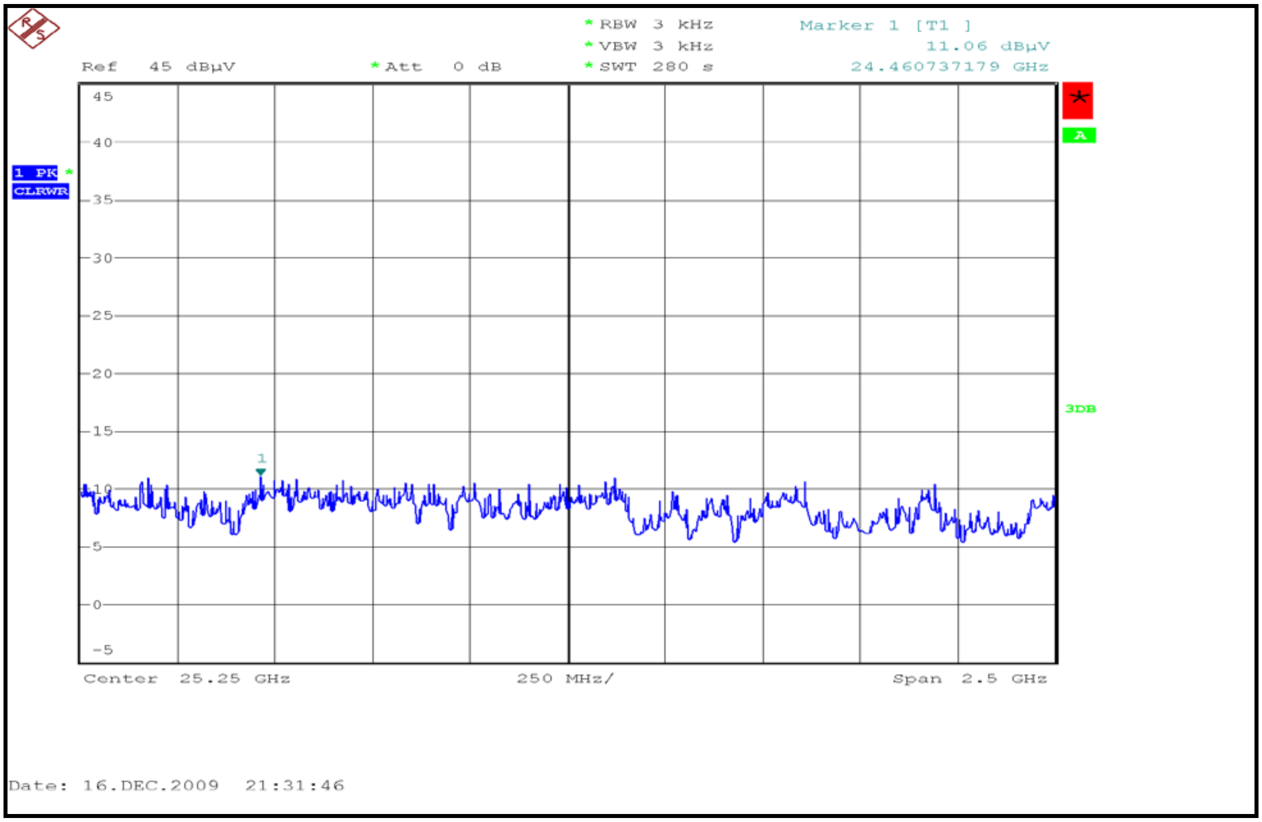
Plot 5-21: Analyzer Noise Floor Level - EUT [48-mm Metal Antenna] in Fiberglass Tank



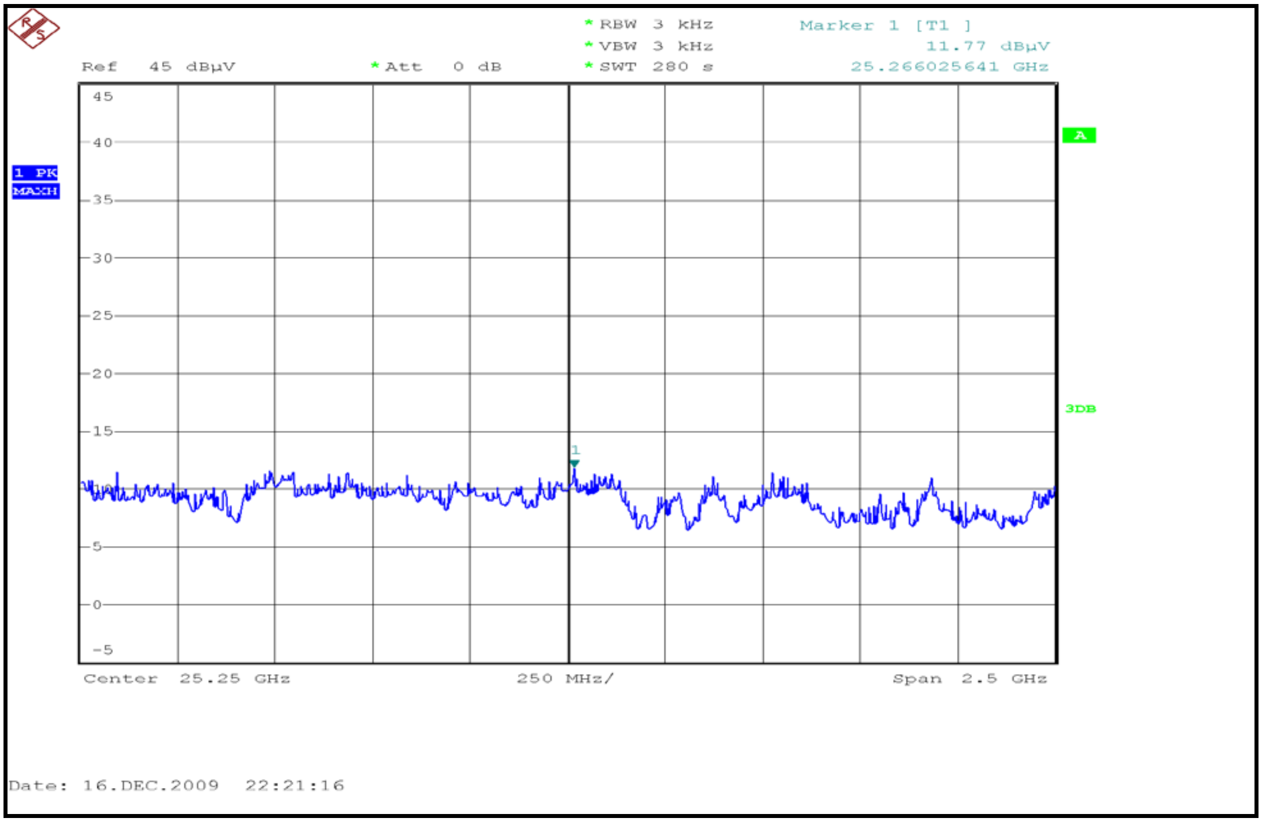
Plot 5-22: Analyzer Noise Floor Level - EUT [80-mm Plastic Antenna] in Fiberglass Tank



Plot 5-23: Analyzer Noise Floor Level - EUT [1/2" Stub Antenna] in Fiberglass Tank



Plot 5-24: Analyzer Noise Floor Level - EUT [1/2" Standpipe Antenna] in Fiberglass Tank



Test Personnel:

Desmond A. Fraser		December 16, 2009
EMC Test Engineer	Signature	Date of Test

6 Restricted Bands - §15.205

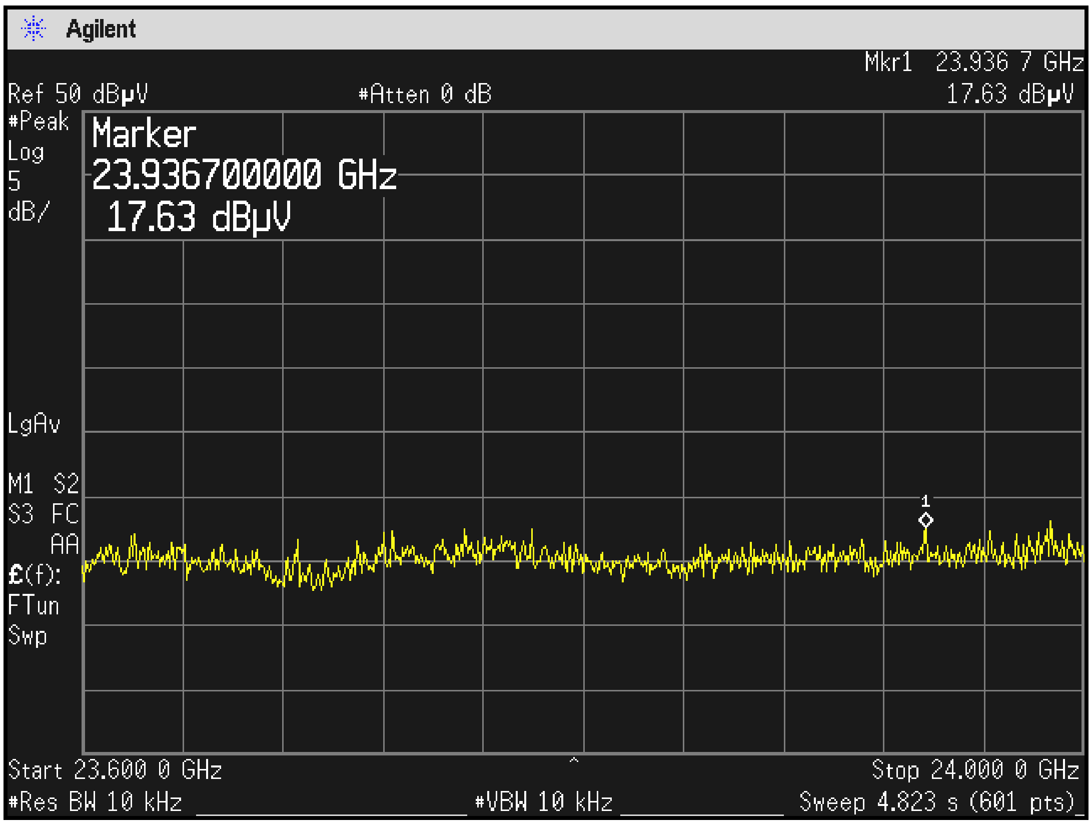
6.1 Restricted Band Limits - §15.205 – Test Procedure

6.1.1 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 3-1 was used, including the same analyzer settings used for measuring the carrier, specifically 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 6-1: 23.6-24 GHz Restricted Band



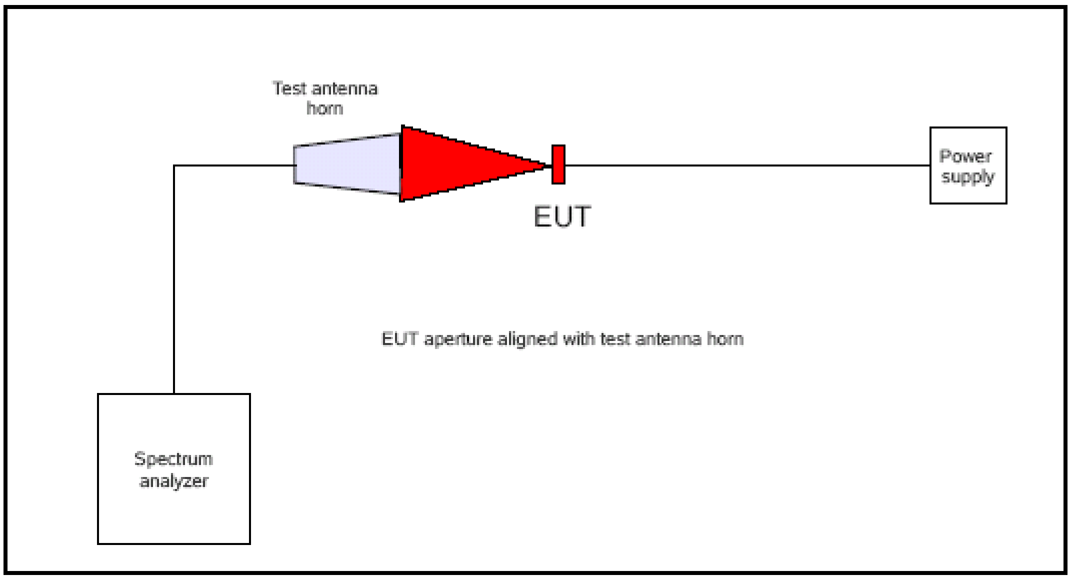
7 Bandwidth Measurement - §15.403(c)

7.1 26 dB Emission Bandwidth Procedure

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 Figure 7-1 below.

Figure 7-1: 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

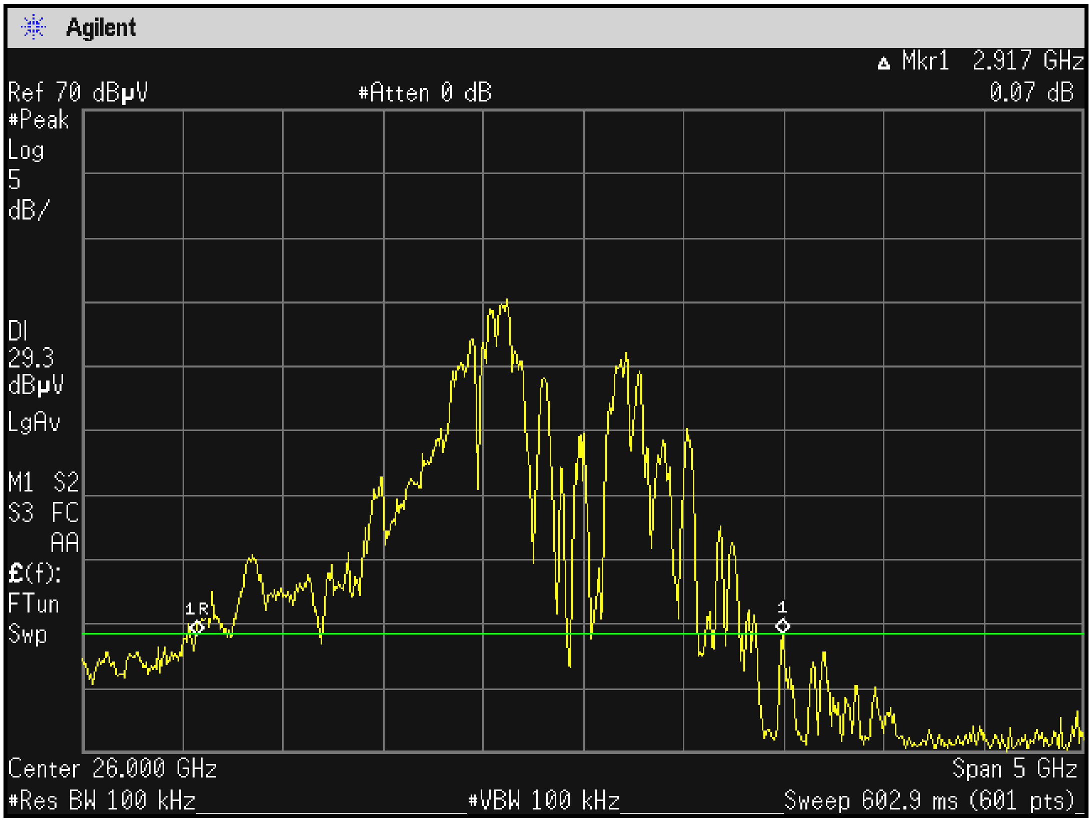
Trace = max hold

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 as close as possible to being even with the reference marker level. The marker-delta reading at this point is the 26dB bandwidth of the emission. The 26 dB bandwidth is 2.917 GHz.

Plot 7-1: 26 dB Bandwidth



7.2 2/ (τ_{eff}) Bandwidth Calculation

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

With τ_{eff} = 0.6 ns, the main lobe bandwidth = 2/(τ_{eff}) = 2/(0.6x10^{-9}s) = 3.3 GHz

8 Test Equipment

Table 8-1: Radiated Spurious Emissions Test Equipment

VEGA/RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901218	EMCO	3160-09	Horn Antenna (18 – 26 GHz)	960281-003	5/9/11
900392	Hewlett Packard	E4448	Spectrum Analyzer	3525A00159	7/9/11
N/A	Rhode & Schwarz	FSV 40	Spectrum Analyzer	N/A	4/6/12
900388	Ciao Wireless	CA1826-302	Pre-Amplifier	N/A	7/9/11
900669	Flann	20240-20 UBR220	Horn Antenna (18 – 26 GHz)	805 1905-1	7/9/11
900888	Huber + Suhner	Sucoflex 104	2m Coaxial Cable	171100/4	7/9/11
900889	Huber + Suhner	Sucoflex 104	2m Coaxial Cable	97045/4	7/9/11
900717	Hewlett Packard	11970U	Harmonic Mixer (40 - 60 GHz)	2332A01110	8/19/11
901218	EMCO	3160-09	Horn Antenna (18 - 26 GHz)	960281-003	6/14/11
900715	Hewlett Packard	11970V	Harmonic Mixer (50 - 75 GHz)	2521A00512	7/19/11
900716	Hewlett Packard	11970W	Harmonic Mixer (75 - 110 GHz)	2521A00710	6/08/11
900126	Hewlett Packard	11970A	Harmonic Mixer (26 - 40 GHz)	2332A01199	6/08/11
900056	ATM	19-443-6	Horn Antenna (40 – 60 GHz)	8041704-01	6/08/11
900826	ATM	08-443-6	Horn Antenna (90 – 140 GHz)	8041904-01	6/08/11
900719	ATM	05-443-6	Horn Antenna (140 – 220 GHz)	50685	6/08/11
900661	ATM	10-443-6	Horn Antenna (75 – 110 GHz)	805 1905-1	6/08/11
901262	EMCO	3160-9	Horn Antenna (1 – 18 GHz)	6748	9/09/11
900723	Hewlett Packard	8447	AMP-1 GHz – 26 GHz	NA	6/08/11
900444	Miteq	1037	Amplifier (30 – 1000 MHz)	PR1040	6/08/11
900791	Schaffner - Chase	CBL6112	Antenna (25 MHz - 2 GHz)	2099	7/07/11
900151	Rohde & Schwarz	HFH2-Z2	Loop Antenna (9 kHz - 30 MHz)	827525	8/09/11
900772	EMCO	3161-02	Horn Antenna (2 – 4 GHz)	9804-1044	7/08/11
900321	EMCO	3161-03	Horn Antenna (4 - 8.2 GHz)	9508-1020	7/08/11
900323	EMCO	3161-07	Horn Antenna (8.2 - 12 GHz)	9508-1054	7/08/11

9 Conclusion

The data in this report demonstrates that the VEGA Grieshaber KG FCC ID: O6QPS60XK1, Models VEGAPULS 61, VEGAPULS 62 and VEGAPULS 63 configured pointing downwards in closed metal, concrete and reinforced fiberglass tanks when tested on an OATS site, comply with the emissions requirements of Parts 2 and 15 of the FCC Rules and Regulations.