INGENIUM TESTING, LLC

ELECTROMAGNETIC COMPATIBILITY (EMC)

CERTIFICATION TEST REPORT FOR

FORTREZZ, LLC

FOR THE WWA-01WIRELESS WATER AND FREEZE ALARM

DOCUMENT NUMBER: CTR-20025, REVISION B

APPROVED BY	SIGNATURE	DATE
President, TWC: Ed Stiltner	Ed Stiltner	06/03/09
Vice-President, Engineering: Louis Luedtke		June 03 '09
Vice-President, Operations: Michael Caruso		6/3/09

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TITLE:

EMC CERTIFICATION TEST REPORT FOR FORTREZZ, LLC FOR THE WWA-01 WIRELESS WATER AND FREEZE ALARM

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DATE
June 3,2009

RECORD OF REVISIONS			
REVISION	DESCRIPTION	DATE	APPROVED
A	Incorporated Revisions to Figure 1, Revised Section 1.7, Added new Cal Due Date to ETS/Asset #1360, Revised 2.1.1.4, and Added Section 2.1.9	5/11/2009	M.Ernest
B	Incorporated Revisions to Table 9, Figure 11 and Figure 12	6/2/2009	M. Ernest

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1.0 SCOPE

Between March 24TH and 31ST, 2009, a series of radiated RF Emissions (EMC) tests were performed on two production samples of the Fortrezz Wireless Water and Freeze Alarm, model "WWA-01", tagged as serial number "Engineering Sample ES1 and ES2", here forth referred to as the "*Equipment Under Test*" or "*EUT*". The emissions characteristics of the EUT were tested in transmit and receive modes and the results are covered in this report.

The radio frequency (RF) emission tests were performed in accordance with 47 CFR, issue (2008-10), Subpart C, for an *Intentional Radiator* product, qualifying under section 15.249, as well as Subpart B, for an *Un-Intentional Radiator* product, qualifying under section 15.109, using the emission standards test procedures outlined in ANSI C63.4 (2003), with test instruments adhering to CISPR 16-2 guidelines. The tests were performed according to a test plan matrix with the consensus of Fortrezz, LLC (client), and Ingenium Testing, LLC (Third Party Test Facility), with the EUT in pre-set operating modes prepared in advance by Fortrezz, LLC. This test plan matrix is here forth referred to as the *"Fortrezz Test Plan".*

The tests were performed to allow verification, in part, of the product's EMI compliance in accordance with the EMC standards in the United States of America and abroad. The tests were performed by Abtin Spantman, EMC Engineer at Ingenium Testing.

2.0 GENERAL

1.1 General Product Description

The Fortrezz WWA-01 Wireless Water & Freeze Alarm is an alarm transceiver that is activated by a trigger. The trigger can take one of two forms: the presence of a current carrying material such as water, or by exceeding a temperature threshold, such as freezing conditions. The WWA-01 Wireless Water & Freeze Alarm uses the Z-Wave ™ network protocol, is a Z-Wave ™ enabled device, and will send a water leak alert on any Z-Wave ™ enabled network. A WWA-01 unit that is not in a Z-Wave™ network will still alert you to water leaks using the on-board audio alarm. This product will provide the user with the peace of mind and protection against leaking pipes, corroded water heaters, water storage tanks, fixtures in bathrooms, and laundry rooms and the like.

Figure 1: The Fortrezz WWA-01 Wireless Water and Freeze Alarm, Front View (Left) and Back View (Right)

1.2 Detailed Product Description

The Fortrezz WWA-01 Wireless Water & Freeze Alarm transceiver has a transmitter function operating at a fundamental carrier frequency of 908.41 MHz, with an effective radiated power (ERP) of approximately 0.1 mW. The transmitter uses 40 kbps binary data with FSK modulation with approximately 121 kHz of occupied bandwidth. These characteristics are strictly a function of the RF sub-module, transceiver model 'ZM3102N' produced by Zensys, and are not controlled by the end user.

The WWA-01 uses a single type (1/2AA) battery at 3.6 VDC, 1200 mA rating, and does not have any facilities to use power from any other source.

The WWA-01 has an integrated internal PC-Board trace monopole antenna, and does not have any facilities for using any other types of antennas.

The WWA-01 does not have any contingencies for peripheral connections. The only link capability is through the RF network connection.

1.3 Modes of Operation

After commissioning, the WWA has two modes of operation: Stand-by and Alarm.

- **Stand-by mode:** During Stand-by, the unit is **in receive mode**, and does not transmit. This mode will be tested for compliance with the 47 CFR 15.109 regulatory guidelines.
- **Alarm mode:** During Alarm, the unit **transmits periodically**. This mode will be tested for compliance with the 47 CFR 15.249 regulatory guidelines.

Two samples of the EUT were provided for testing. One sample, designated "Engineering Sample 1" or "ES1" was programmed for continuous transmission. The second sample, designated "Engineering Sample 2" or "ES2" was in normal operation.

1.3.1 Mode of Operation during RF Emission Testing

During radiated emission testing, both samples should be tested.

For transmitter tests, the "ES1" unit should be tested for peak power measurements, and "ES2" unit should be used in **Alarm Mode**, to verify spurious emissions, channel and bandwidth occupancy, and any other transmit-timing functions that may be applicable.

For receiver tests, the "ES2" unit should be tested in **Stand-by Mode**.

1.4 Equipment Under Test (EUT) Tracking Information

The following information has been supplied by the applicant.

Product Name:	Wireless Water and Freeze Alarm
Model Number:	WWA-01
Serial Number:	Production units ES1 and ES2

Table 1: Equipment Under Test (EUT) Product Information

1.5 Equipment Under Test (EUT) Technical Specifications

Frequency Range (in MHz)	908.42 MHz
RF Power in Watts	0.1 mW
Field Strength (and at what distance)	65.6 dBµV/m at 10m
Occupied Bandwidth (99% BW)	121.6 kHz
Type of Modulation	FM/FSK
Emission Designator	F1D-CN-122k
Transmitter Spurious (worst case)	18.1 dBµV/m at 10m
Frequency Tolerance %, Hz, ppm	50 ppm (46 kHz)
Operating Temperature Range	-10ºC (14F) to +70ºC (158F)
Microprocessor Model # (if applicable)	ZW0301
EUT will be operated under FCC Rule Part(s)	47 CFR 15.249
Modular Filing	☐ Yes ☒ No
Design Engineer (optional)	N/A
Cabinet Size	2.4" x 1.6" x 0.8"
Cabinet Weight	0.2 Pounds
Power Requirements	One 3.6V 1/2AA 1200mAh Lithium Battery, ER14250H, LS14250 or equivalent
Environmental Operating conditions	Residential and Light Industrial
Communication Ports	None
Alarm Output	Through RF Network only

Table 2: Equipment Under Test (EUT) Technical Specifications

1.6 Associated Antenna Description

The only antenna on the system is an integrated internal PC-Board trace monopole antenna.
There are no contingencies for any other types of antennas.
The antenna is not accessible to the end user.
The antenna is not adjustable.

1.7 RF Technical Information

Type of Evaluation (Check One)		SAR Evaluation: Device Used in the Vicinity of the Human Head
		SAR Evaluation: Body-Worn Device
	X	RF Evaluation

If RF Evaluation is checked above, test engineer to complete the following:

- Evaluated against exposure limits: ☒ General Public Use ☐ Controlled Use
- Duty Cycle used in evaluation: 100%
- Standard used for evaluation: 47 CFR 2.1091
- Measurement Distance: 20 cm
- RF Value: **0.00002** ☐ V/m ☐ A/m ☒ **W/m^2**
  ☒ **Measured** ☐ Computed ☐ Calculated

1.8 Applicable Normative Documents

The following documents are referenced in the construction of this test portfolio.

Table 3: Regulatory Documents

Publication	Year	Title
47 CFR, Parts 0-15 (FCC)	Release Date 2008-07-10	United States of America Code of Federal Regulations Title 47 – Telecommunications.
RSS-210	Issue 7 (2007-06)	Industry Canada Spectrum Management and Telecommunications Radio Standard Specification. Low-power License-Exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment.
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
CISPR 16-1-1	Edition 2.1 (2006-11)	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus.
CISPR 16-1-2	Edition 1.2 (2006-08)	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-2: Ancillary equipment – conducted disturbances.
CISPR 16-2-1	Edition 1.1 (2005-09)	Specification for radio disturbance and immunity measuring apparatus and methods. Part 2-1: Conducted disturbance measurement.

CISPR 16-2-2	Edition 1.2 (2005-09)	Specification for radio disturbance and immunity measuring apparatus and methods. Part 2-2: Measurement of disturbance power.
CISPR 16-2-3	Second Edition (2006-07)	Specification for radio disturbance and immunity measuring apparatus and methods. Part 2-3: Methods of Measurement of disturbance and immunity – Radiated disturbance measurements.

Table 4: Non-Regulatory Controlled Documents from Fortrezz or Ingenium Testing, LLC.

Document	Owner	Title
WWA-01 Wireless Water & Freeze Alarm Instruction manual	Fortrezz, LLC	WWA-01 Wireless Water & Freeze Alarm Instruction manual
JCEAQ1063	Ingenium Testing, LLC	Statement of Work

1.9 Operational Definitions and Performance Criterion

Manufacturer and Device-Specific Operational Definitions and Performance Criterion:
In normal operational mode, the "ES2" unit shall operate per manufacturer specifications.
In specific programmed test mode, the "ES1" unit shall operate continuously as a transmitter (CW mode), with the sounder off to conserve battery life during testing.

Performance Criterion A:
N/A

Performance Criterion B:
N/A

Performance Criterion C:
N/A

1.10 Applicable Test Matrix and Test Results

The following matrix defines the scope of testing as covered by this report, and agreed to between Fortrezz, LLC (Client) and Ingenium Testing, LLC.

This series of testing is performed to verify that the electromagnetic performance of the "Fortrezz Wireless Water and Freeze Alarm" adheres to the expected performance stated in the aforementioned standards. These tests verified that the transmitter characteristics met the specific limits dictated by 47CFR 15.249, and that the receiver characteristics met the specific limits dictated by 47CFR 15.109. The following matrix describes the test regiment.

Table 5: Test Matrix and Test Results

Port Definition	Terminal Name	Description/ Detail	Test Standard	Performance Criteria	Pass / Fail
Enclosure	N/A	Alarm Enclosure containing digital circuitry ***Transmit Mode***	Radiated RF Emissions 47 CFR 15.249	30 MHz-12.0 GHz Measured RF Emission should be Below specified Limits	Pass
Enclosure	N/A	Alarm Enclosure containing digital circuitry ***Receive Mode***	Radiated RF Emissions 47 CFR 15.109	30 MHz-12.0 GHz Measured RF Emission should be Below specified Limits	Pass

1.11 Notes and Exceptions to Report

None.

1.12 Declaration of Conformity

DECLARATION OF CONFORMITY

The Fortrezz "Wireless Water and Freeze Alarm" model 'WWA-01' wireless alarm transceiver unit, serial number "ES1 and ES2" were found to ***MEET*** *the emission and performance requirements as described within the specifications of Title 47, Part 15, of the Code of Federal Regulations for the United States of America.*

The Fortrezz "Wireless Water and Freeze Alarm" model 'WWA-01' wireless alarm transceiver unit meets the requirements of 47 CFR 15.249, subpart C, for an intentional radiator product in transmit mode, and meets the requirements of 47 CFR 15.109, subpart B, for an un-intentional radiator in receive mode. The conformity statement is limited in scope to the testing that was commissioned and administered and covered in this report.

If some emissions are seen to be within 3 dB of their respective limits:
As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

Ingenium Testing, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT, subsequent to the indicated test date(s), will invalidate the data herein, and void this certification.

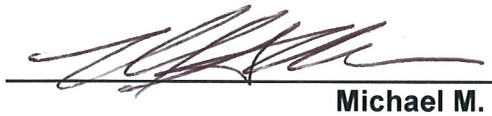
1.13 Signatories

The test matrix presented in section 1.5 of this report was generated, in agreement, by the cognizant parties representing the client as the manufacturer of the equipment, and by the cognizant parties at Ingenium Testing. The performance of the tests and reporting of the results are accurate to the best of our collective knowledge as presented within the body of this report.

The testing of this product was approved by the cognizant parties representing the manufacturer:

Manufacturer Name:	FORTREZZ **Fortrezz, LLC**
Address:	520 Aarons Way Ortonville, MI 48462 United States of America
Contact Person:	Mr. Carl Szasz Fortrezz, LLC 520 Aarons Way Ortonville, MI 48462 United States of America PH: +1 248 760 5883 EM: CSZASZ@Yahoo.com

This Test Report is issued under the Authority of:



Michael M. Miller
Laboratory Manager, Ingenium Testing, LLC

6-3-09
Date

The testing was performed by:

Abtin Spantman
RF/EMC Engineer, Ingenium Testing, LLC

June 3, 2009
Date

1.14 Test Facility and Accreditations

Ingenium Testing, LLC is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025, 2005 "General Requirements for the Competence of Calibration and Testing Laboratories".

Ingenium Testing, LLC's scope of accreditation includes all test methods listed herein, unless otherwise noted. A copy of the accreditation may be accessed on our web site: www.ingeniumtesting.com. Accreditation status can be verified at A2LA's web site: www.a2la2.net.

1.15 Location of Test Facility

All testing was performed at Ingenium Testing, LLC, 3761 South Central Avenue, Rockford, Illinois, 61102-4292, United States of America, utilizing the facilities listed below, unless otherwise noted.

List of Facilities used at Ingenium Testing, LLC:

- 10-meter SEMC-Anechoic Chamber designated Chamber number 6.
- 3-meter Semi-Anechoic Chamber designated Chamber number 10.
- RF Shielded room designated Chamber 11.
- RF Shielded room designated Chamber 12.

3.0 TEST DETAILS

2.1 Electromagnetic Emission Tests

2.1.1 Radiated RF Emissions Measurements

2.1.1.1 Test Criterion

The test matrix in section 1.5 was used as a guide for test points and conditions.

Port Definition	Terminal Name	Description/ Detail	Test Standard	Performance Criteria	Pass / Fail
Enclosure	N/A	Alarm Enclosure containing digital circuitry ***Transmit Mode***	Radiated RF Emissions 47 CFR 15.249	30 MHz-12.0 GHz Measured RF Emission should be Below specified Limits	Pass
Enclosure	N/A	Alarm Enclosure containing digital circuitry ***Receive Mode***	Radiated RF Emissions 47 CFR 15.109	30 MHz-12.0 GHz Measured RF Emission should be Below specified Limits	Pass

The following tables present the limits for intentional radiated RF emissions, at the fundamental frequency, and harmonic frequencies as specified in Title 47 CFR, Part 15.249, section (a). These limits were also applied to any signals found in the restricted frequency bands as defined in 47 CFR, Part 15.205.

Emission	Field Strength Limit at 3m (mV/m)	Field Strength Limit at 3m (μV/m)	Field Strength Limit at 3m (dBμV/m)	Field Strength Limit at 10m (dBμV/m)
Fundamental: 902-928 MHz	50.0	50,000.0	93.9	83.5
Harmonic: 2^{nd} through 10^{th}	-	500.0	53.9	43.5
Spurious:	-	500.0	53.9	43.5

Table 6: Field Strength Limit for Intentional Radiators under 47CFR 15.249

The following table presents the limits for unintentional radiated RF emissions as specified in Title 47 CFR, Part 15.109, section (a), for products qualifying as Class B Digital Devices. These limits were also applied to any signals found in the restricted frequency bands as defined in 47 CFR, Part 15.205.

Frequency (MHz)	Field Strength Limit at 3m (μV/m)	Field Strength Limit at 3m (dBμV/m)	Field Strength Limit at 10m (dBμV/m)
30 – 88	100.0	40.0	29.5
88 - 216	150.0	43.5	33.0
216 – 960	200.0	46.0	35.5
Above 960	500.0	54.0	43.5

Notes:

In the calculations for margin below the limit, the limits are rounded to one digit past the decimal.

2.1.1.2 Test Equipment

All equipment is calibrated according to governing standards, and is N.I.S.T. traceable. The equipment is used according to the operation manuals as provided by the manufacturers.

Table 7: List of Equipment Used:

Manufacturer	Model	Ingenium Asset Number	Description	Last Cal data	Cal due date
Agilent	E4440A	1207	PSA Spec. Analyzer	Dec 18, 2008	Dec 18, 2009
Agilent	N9039A	1206	Pre-Selector	Dec 23, 2008	Dec 23, 2009
Agilent	N5182	1208	RF Generator	Dec 18, 2008	Dec 18, 2009
A.H. Systems	PAM-0118	1388	Pre-Amplifier	Dec 01, 2008	Dec 01, 2009
ETS	3142C	1360	Hybrid Antenna	Mar 17, 2008	Mar 17, 2010

The data presented accounts for the antenna correction factor as well as cable loss or other corrections, and can, therefore, be entered into the database as a corrected measurement result.

2.1.1.3 Test Setup

The EUT was tested as a "table-top device" type product, as described in ANSI C63.4, and as a "mobile device" as described in 47 CFR Part 2.1091. The EUT was placed on a non-conductive pedestal, centered on a flush-mounted 3 meter-diameter turntable in the 10 Meter FCC Listed Semi-Anechoic Chamber located at Ingenium Testing. The test setup complies with the necessary procedures as described in the ANSI standard. The EUT was exercised under standard operating conditions, and powered by a new single type '½ AA' battery.

Test Setup Photos: Orientations and views during investigation in three orthogonal axes:

Figure 2: Vertical Orientation Reference Point

Figure 3: Horizontal Orientation Reference Point

Figure 4: Side Orientation Reference Point

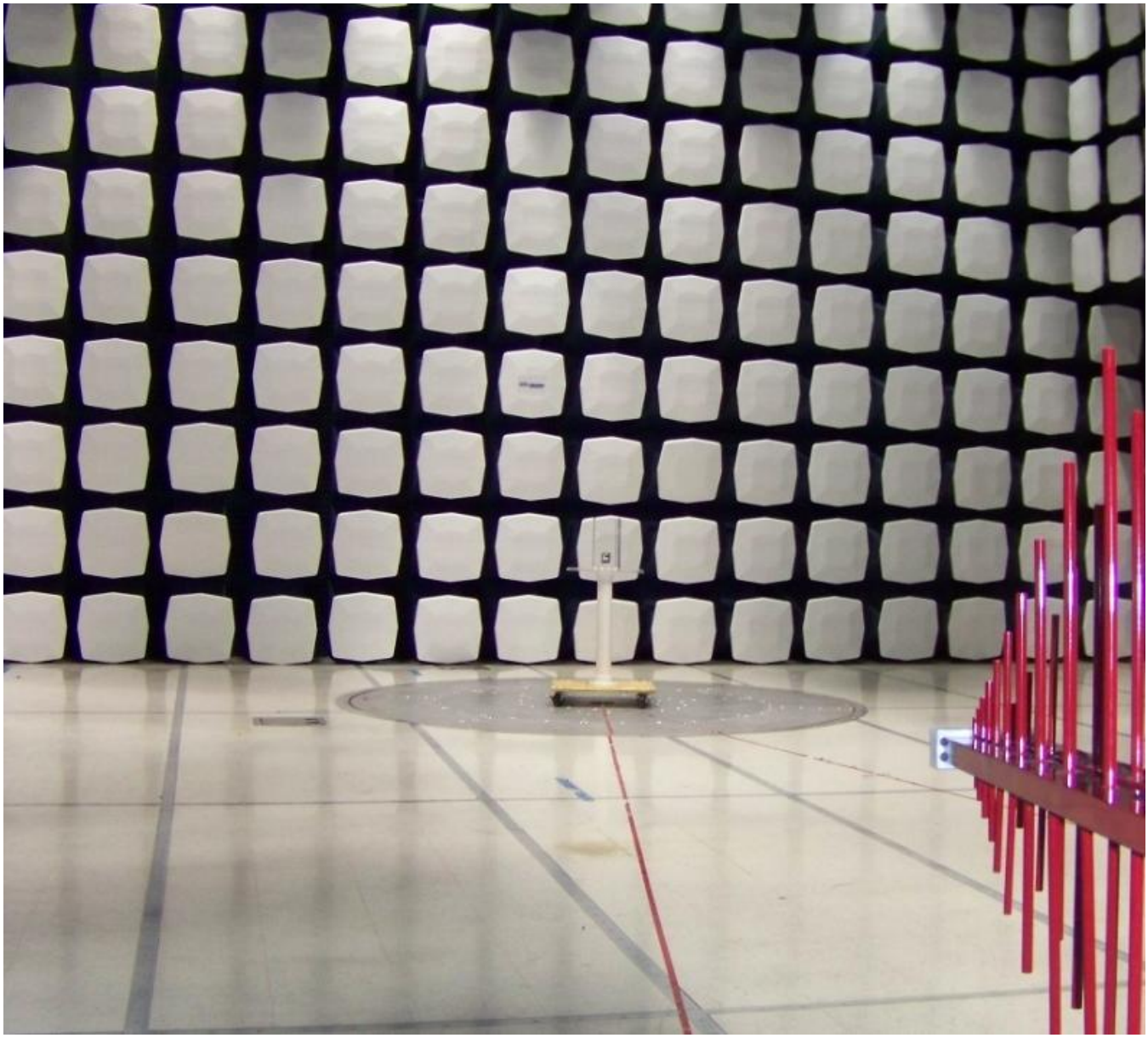


Figure 5: EUT on Test Pedestal as Viewed from the Sense Antenna; Emission Testing Below 1 GHz, at 10m Separation Distance

Figure 6: EUT on Test Pedestal; Emission Testing Above 1 GHz, at 1m Separation Distance

2.1.1.4 Test Procedure

The EUT was measured for Radiated RF Emissions in the 10 Meter FCC Listed Semi-Anechoic Chamber located at Ingenium Testing. The frequency range from 30 MHz to 10 GHz was investigated for RF emissions, and emission levels were noted along with the fixed degree settings of azimuth on the turntable and sense antenna height. The EUT was placed on a non-conductive pedestal, centered on a turn-table with a conductive rotating surface, flush and in contact with the conductive ground plane. The antenna mast was placed such that the antenna was separated by 10 meters from the test object for testing below 1 GHz, and separated by 1 meter for testing above 1 GHz. A Hybrid Bicon-Log Antenna was used to measure emissions from 30 MHz to 1000 MHz. A Double-Ridged Wave-Guide Horn Antenna was used to measure emissions from 1 GHz to 10 GHz. The maximum

radiated emissions were found by raising and lowering the antenna between 1 and 4 meters in height, while utilizing the turn-table to rotate the product. The process was repeated using both horizontal and vertical antenna polarizations. The maximum emission levels were then recorded along with the attitude of the product.

The EUT was set-up in advance, by the client cognizant engineer, in the proper mode. The mode tested was in continuous-transmit CW, for the intentional radiator testing, and in stand-by for the un-intentional radiator testing. The alarm sounder was deactivated in order to conserve battery power during CW testing.

The applicable limits as noted in 47 CFR 15.249 were applied for the intentional radiator tests.
The applicable limits as noted in 47 CFR 15.109 for a Class B type product were applied for the un-intentional radiator tests. The receiver was operated with a resolution bandwidth (RBW) of 120 kHz for measurements below 1 GHz (video bandwidth of 300 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 3 MHz).

2.1.1.5 Test Results

The EUT was found to **MEET** the requirements as described within the specifications of the FCC, Title 47 CFR, Part 15.249 for radiated emissions from an intentional radiator.
The EUT was found to **MEET** the requirements as described within the specifications of the FCC, Title 47 CFR, Part 15.109 for radiated emissions from a Class B product, as well as the Industry Canada requirements specified within ICES-003 for a Class B digital device. Supporting evidence of significant measured RF emissions, are tabulated and presented below.

CLIMATE TEST CONDITIONS

Temperature:	73 °F (22.8 °C)
Humidity:	48 % RH

Table 8: Level of Significant Spurious Radiated RF Emissions Measured

Mode (Tx / Rx)	Frequency (MHz)	Antenna Polarization	Height (cm)	Azimuth (0° - 360°)	Measured EFI (dBμV/m@10m)	15.109 Limit (dBμV/m@10m)	Margin (dB)
Tx					(Note 3)		
Rx					(Note 3)		

Table 9: Level of Significant Radiated RF Emissions Measured in Transmit Fundamental and Harmonic Frequencies

Frequency (MHz)	Ant./EUT Polarization	Height (cm)	Azimuth (0° - 360°)	Measured EFI (dBμV/m@10m)	15.249 Limit (dBμV/m)	Margin (dB)
908.4	V / S	167	210	65.6	83.5	17.9
1816.8	V / V	100	110	40.5	63.5	23.0
2725.2	V / V	100	180	27.4	63.5	36.1
3633.6	V / V	105	170	23.8	63.5	39.7
4542.0	-			(Note 3)		
5450.3	-			(Note 3)		
6358.7	-			(Note 3)		
7267.1	-			(Note 3)		
8175.5	-			(Note 3)		
9084.0	-			(Note 3)		

Notes:
1) A Quasi-Peak Detector was used in measurements below 1 GHz, and a Peak as well as an Average Detector were used in measurements above 1 GHz. Measurements using the Average detector are published in the table above for frequencies above 1 GHz. The peak detector was used to ensure the peak emissions did not exceed 20 dB above the limits.
2) Measurements above 1 GHz were made at 1 meter of separation from the EUT.
3) Measurement at receiver system noise floor, and better than 20 dB below limits.

Uncertainty Calculations – All Factors Combined Includes a comparison between CISPR 16-4-2 and Ingenium Testing			
Measurement		U_{CISPR}	Ingenium Testing
Radiated Disturbance	30 MHz – 300 MHz	7.4 dB	5.4 dB
Radiated Disturbance	300 MHz – 1 GHz	6.5 dB	5.1 dB

Notes: Date of Estimation: November 02, 2007.

SCREEN CAPTURES – RADIATED RF EMISSIONS TESTING

These screen captures represent Peak Emissions. For radiated Emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz, and an Average detector function is utilized when measuring frequencies above 1 GHz.

The signature scans shown here are from worst-case emissions, as measured with the sense antenna both in vertical and horizontal polarity.

Transmit Mode

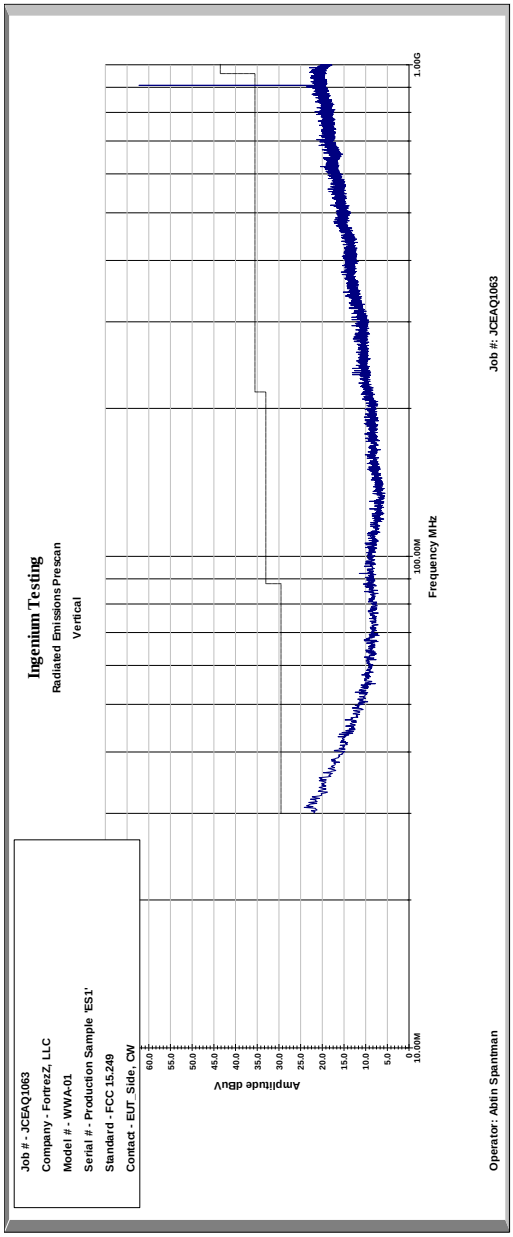


Figure 7: Transmit RF Emission Signature, Antenna Vertically Polarized, 30-1000MHz, at 10m

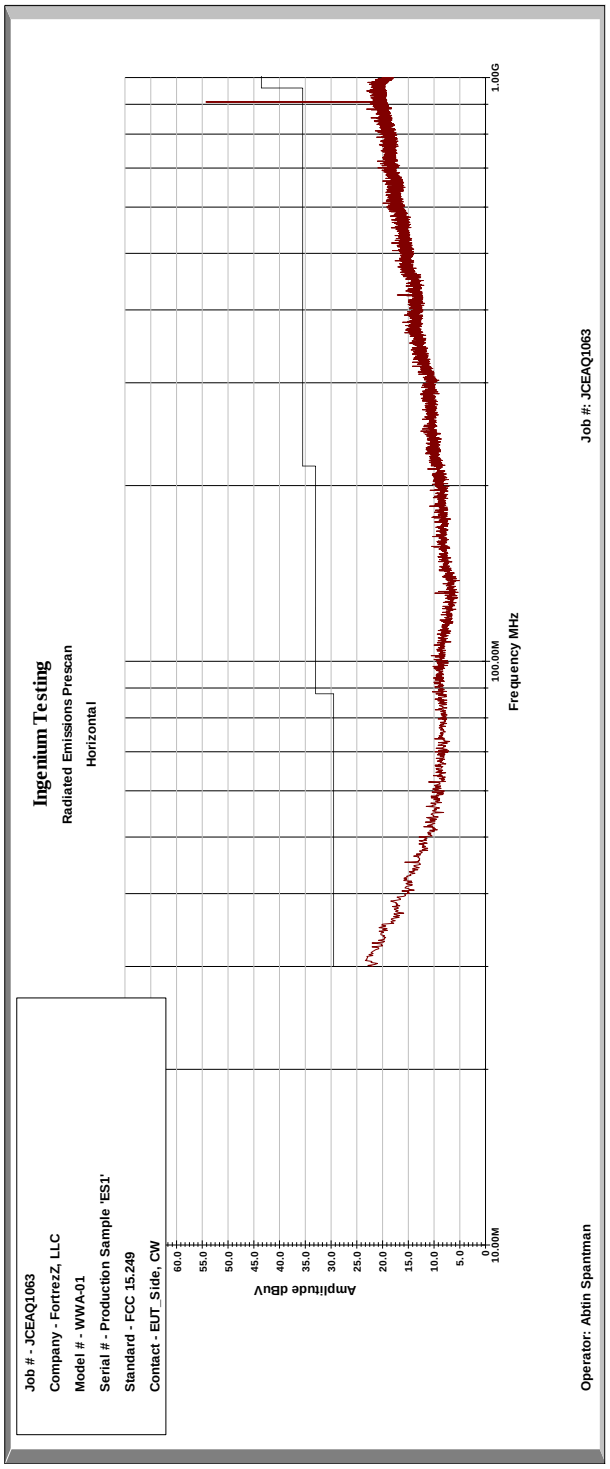


Figure 8: Transmit RF Emission Signature, Antenna Horizontally Polarized, 30-1000MHz, at 10m

Receive Mode

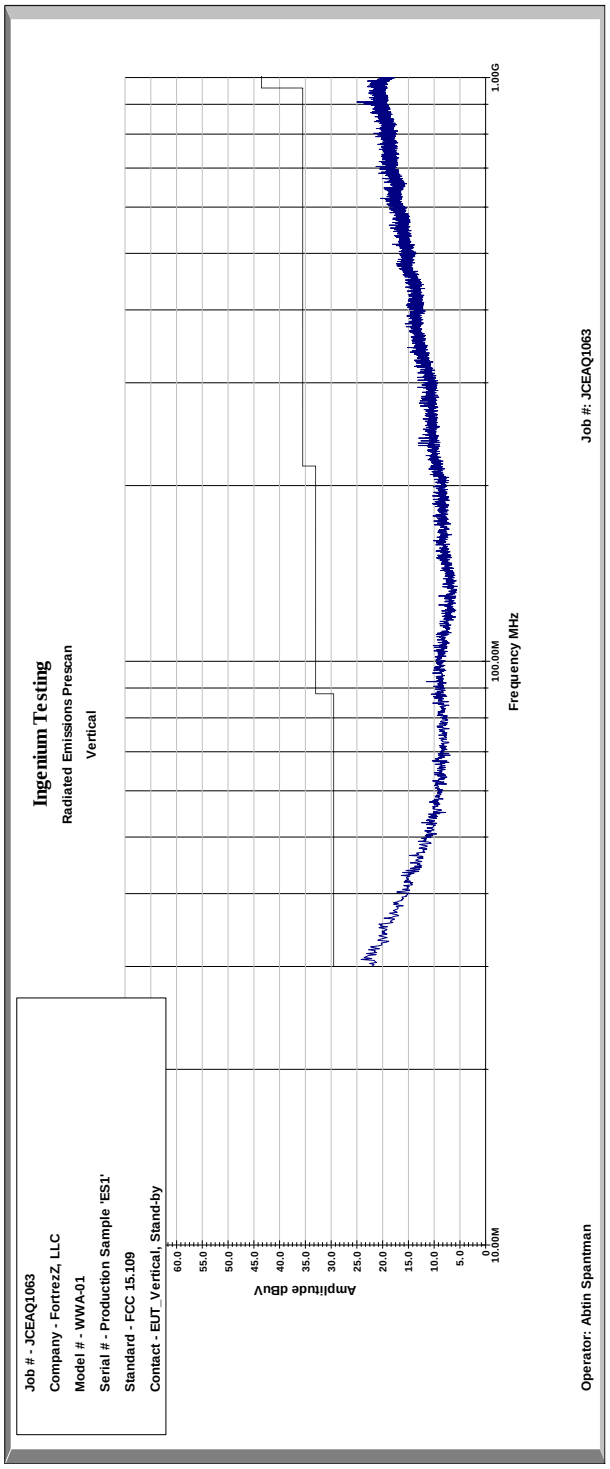


Figure 9: Receive RF Emission Signature, Antenna Vertically Polarized, 30-1000MHz, at 10m

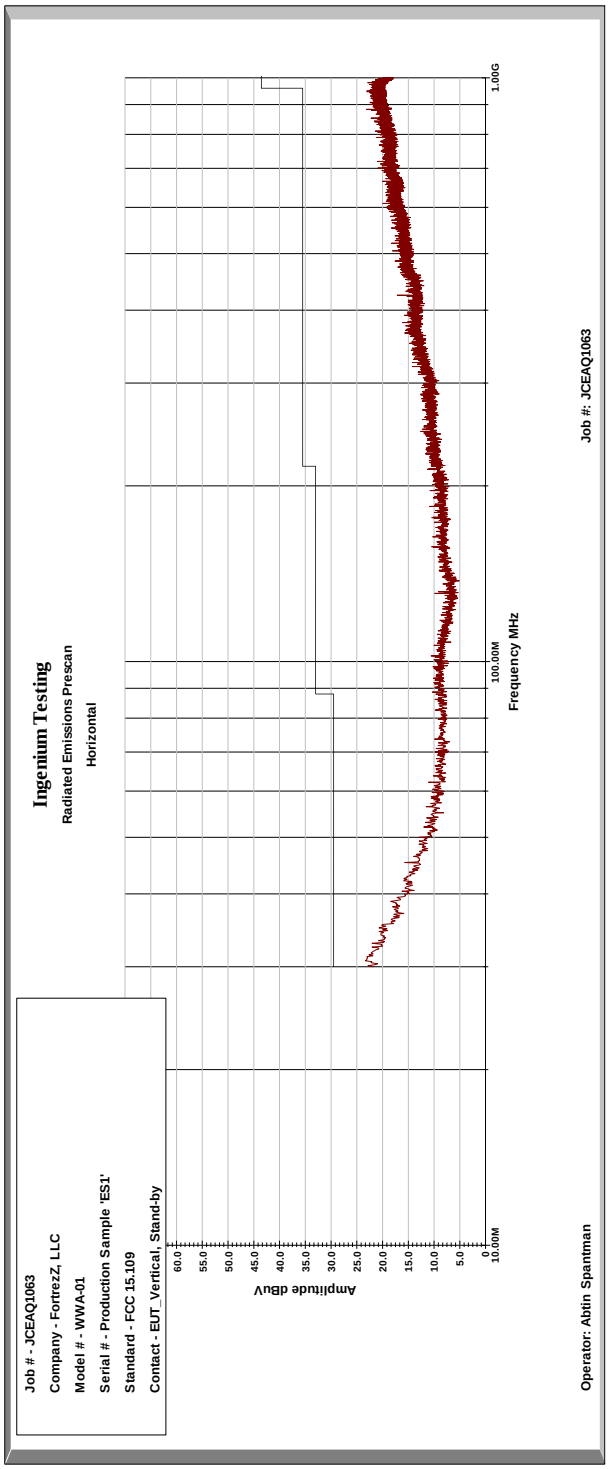


Figure 10: Receive RF Emission Signature, Antenna Horizontally Polarized, 30 – 1000MHz, at 10m

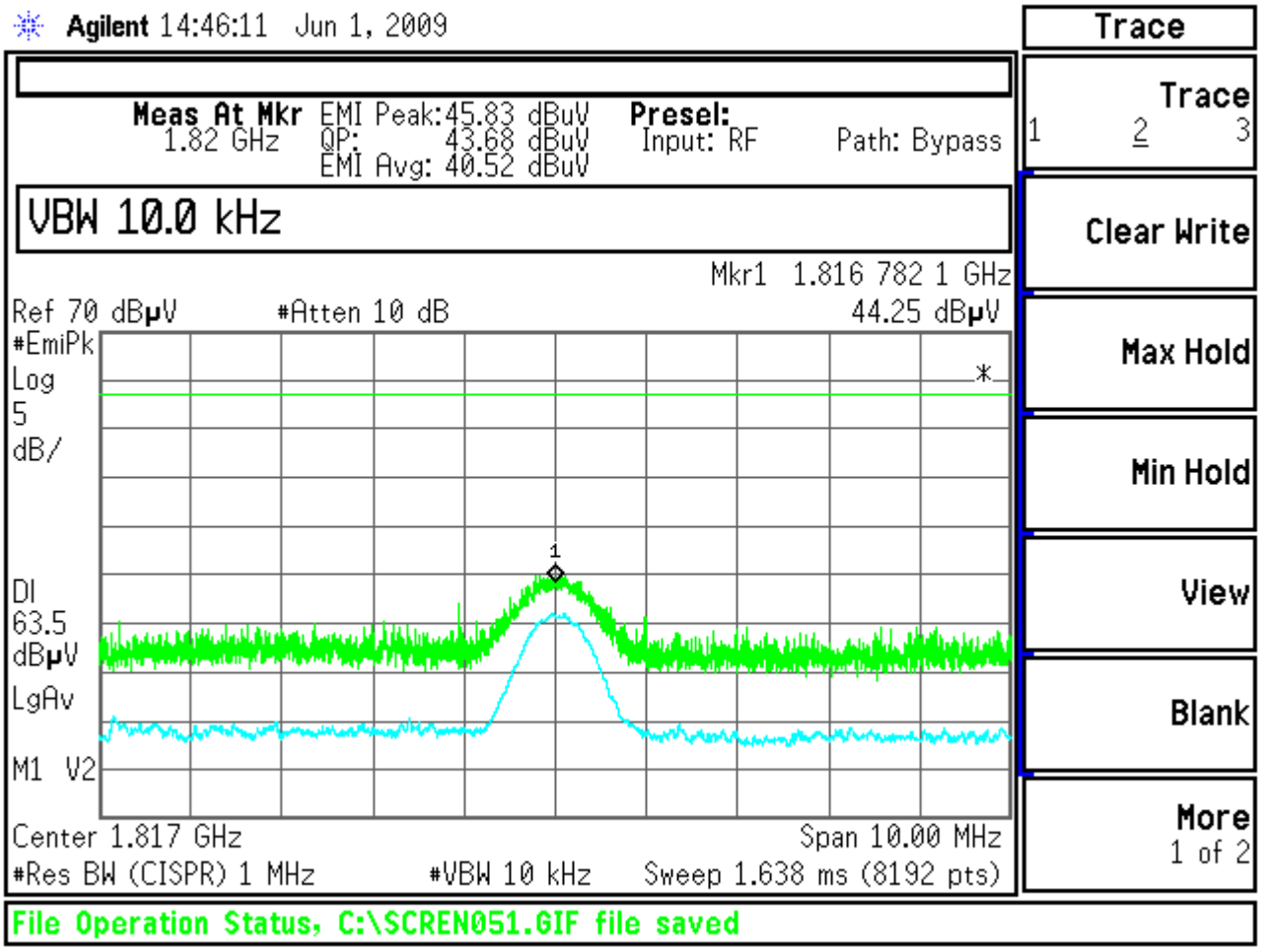


Figure 11: Transmit RF Emission Signature with the Antenna Vertically Polarized, at 1 m Separation, with Reduced RBW also Shown for Better Resolution Showing the 2nd Harmonic at 1.18 GHz

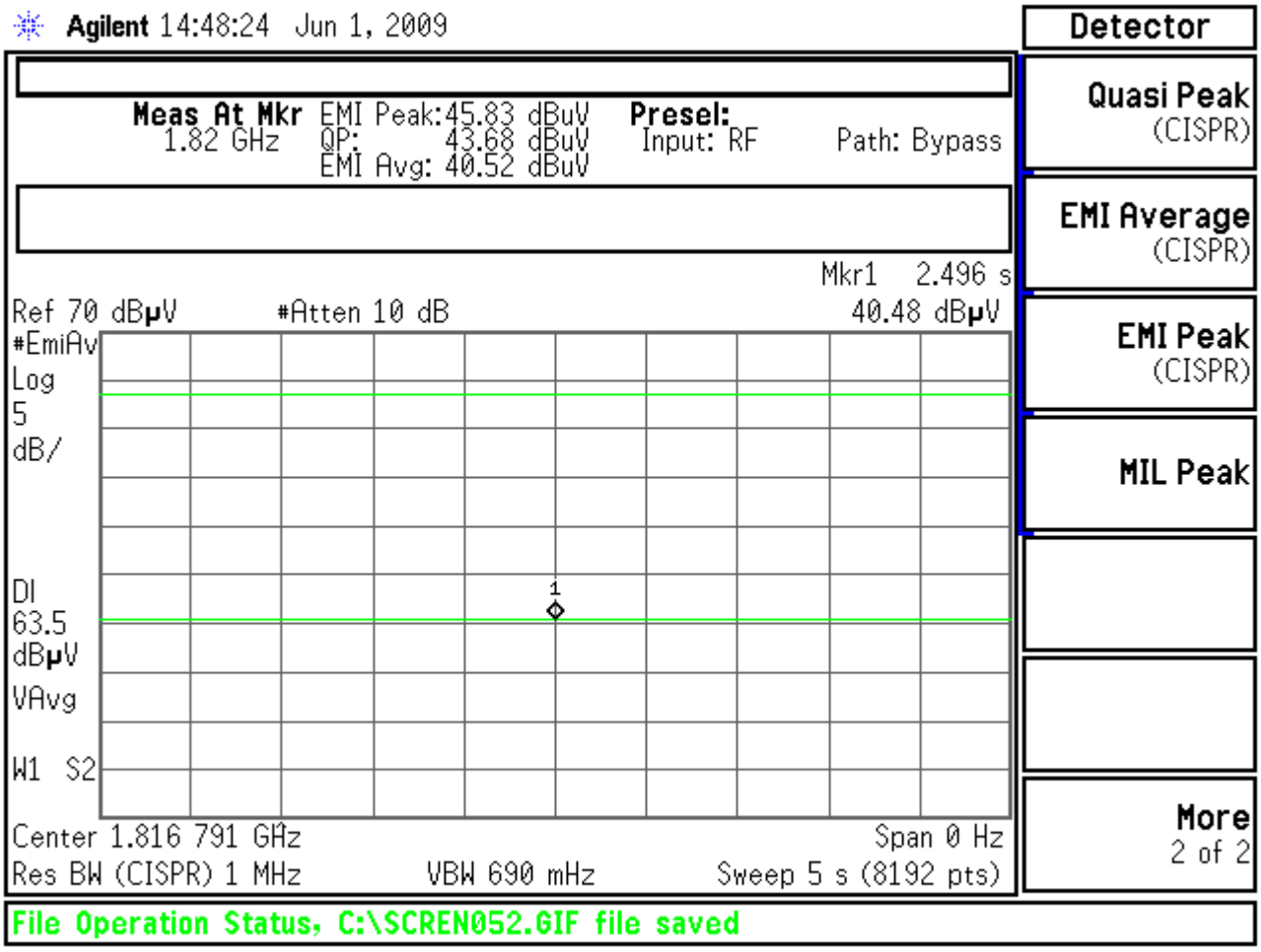


Figure 12: Close Up Investigation of the 2nd Harmonic Using the Average Detector Function

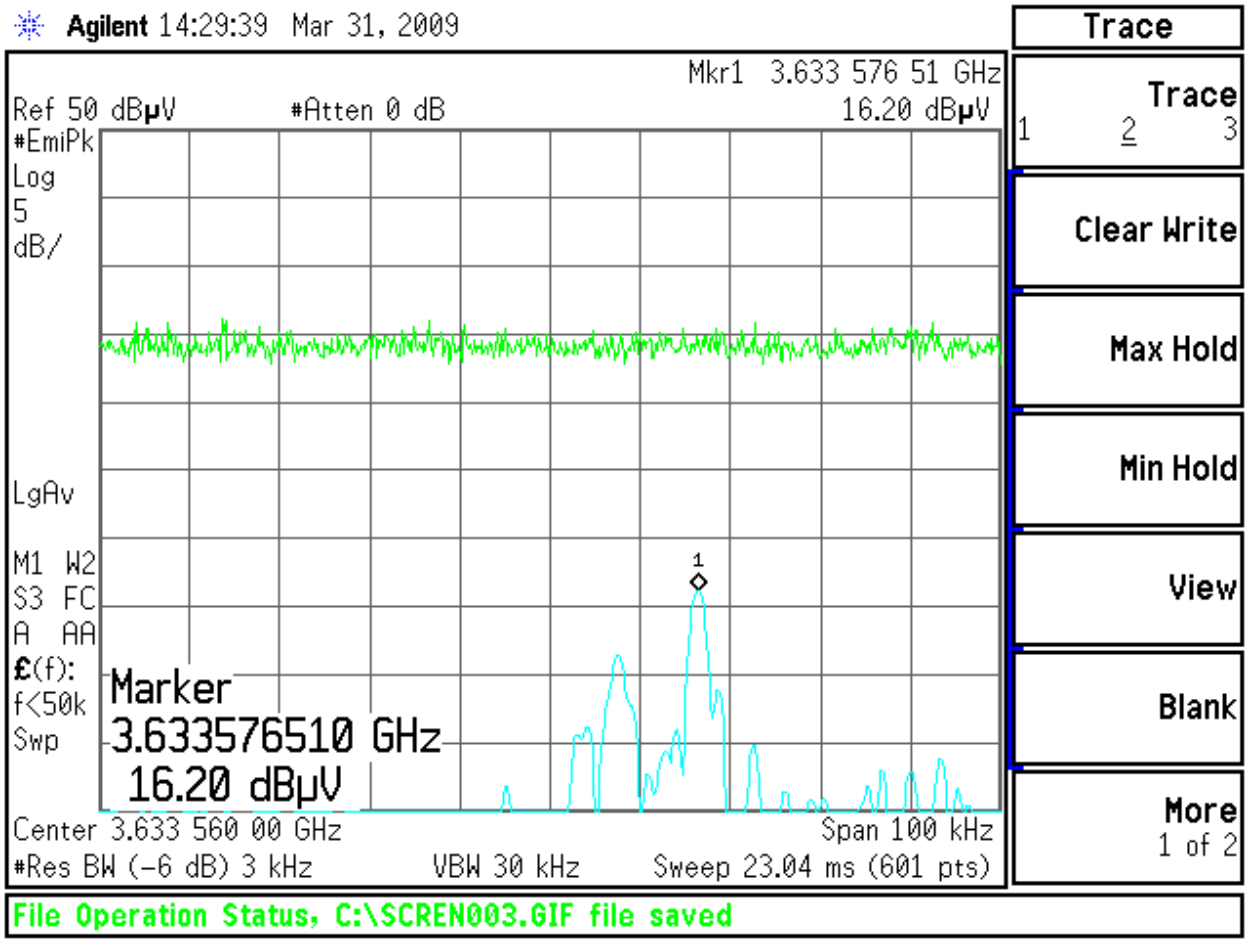


Figure 13: Close Up Investigation of the 3rd Harmonic, Showing the Signal Level is Well Below the Limits, and Visible Only with Reduced Receiver RBW

2.1.2 Conducted RF Emission onto AC Mains Measurements

This device is battery powered only.
Conducted RF Emission measurements are not required for this transmitter.
No tests were performed.

2.1.3 Conducted RF Performance Parameters – Occupied Bandwidth Measurements

2.1.3.1 Test Criterion

Occupied Bandwidth measurements are not required, under part 15.249, for this transmitter.
The following Occupied Bandwidth measurements were made and included here for reporting purpose only.

2.1.3.2 Test Equipment

All equipment is calibrated according to governing standards, and is N.I.S.T. traceable. The equipment is used according to the operation manuals as provided by the manufacturers.

Table 10: List of Equipment Used:

Manufacturer	Model	Ingenium Asset Number	Description	Last Cal data	Cal due date
Agilent	E4440A	1207	PSA Spec. Analyzer	18 Dec 2008	18 Dec 2009
Agilent	N9039A	1206	Pre-Selector	23 Dec 2008	23 Dec 2009

The data presented accounts for the antenna correction factor as well as cable loss or other corrections, and can, therefore, be entered into the database as a corrected measurement result.

2.1.3.3 Test Setup

The EUT did have a 50 ohm path between the transmitter output section and the antenna, as traces and component landing pads on the printed circuit board. This 50 ohm trace is not accessible to the end-user, and is not an antenna port. This 50 ohm path was utilized for direct conducted RF measurements on the functional system.

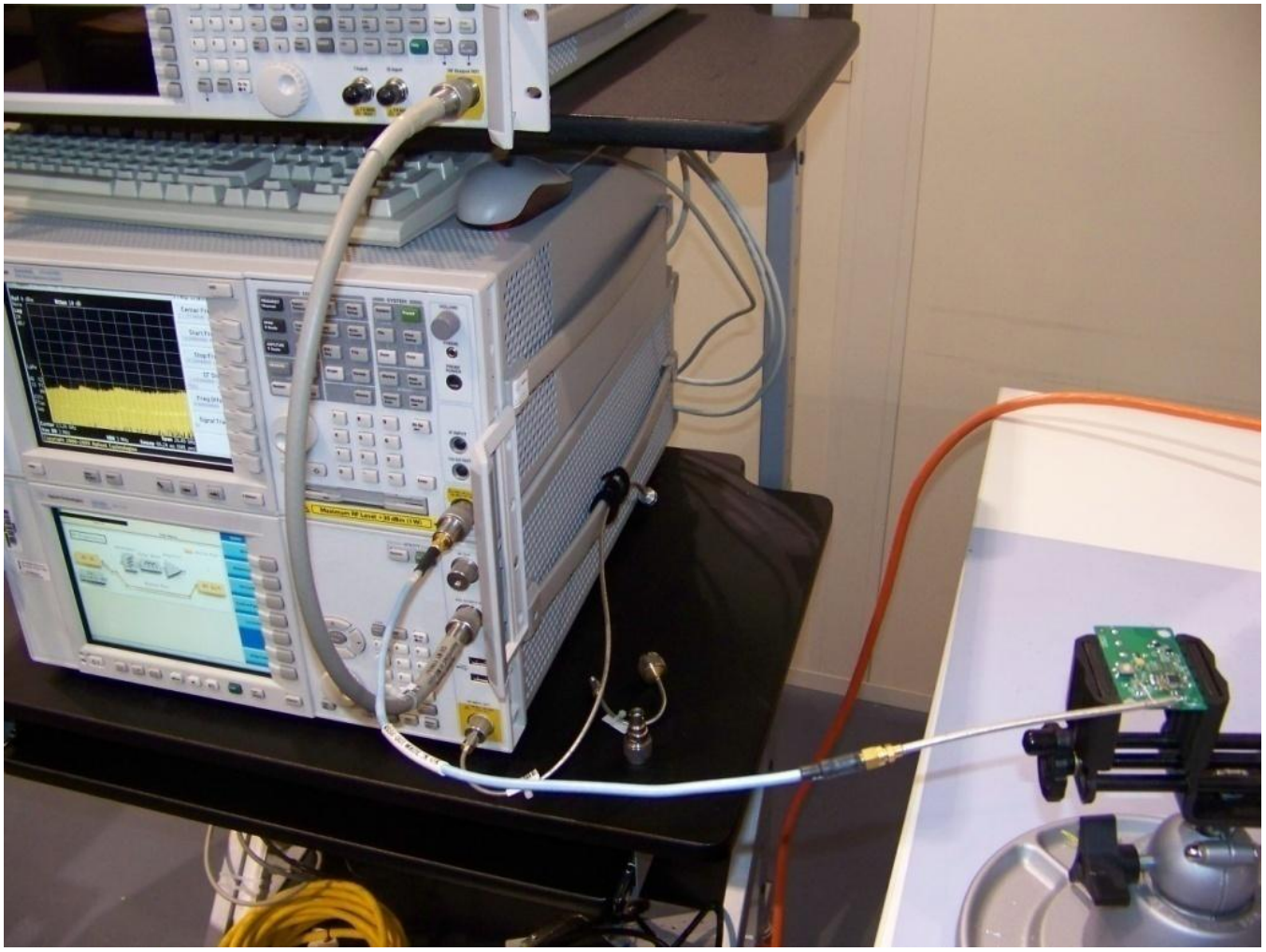


Figure 14: EUT Disposition and Attachment to the Test Instruments During the Conducted RF Measurements

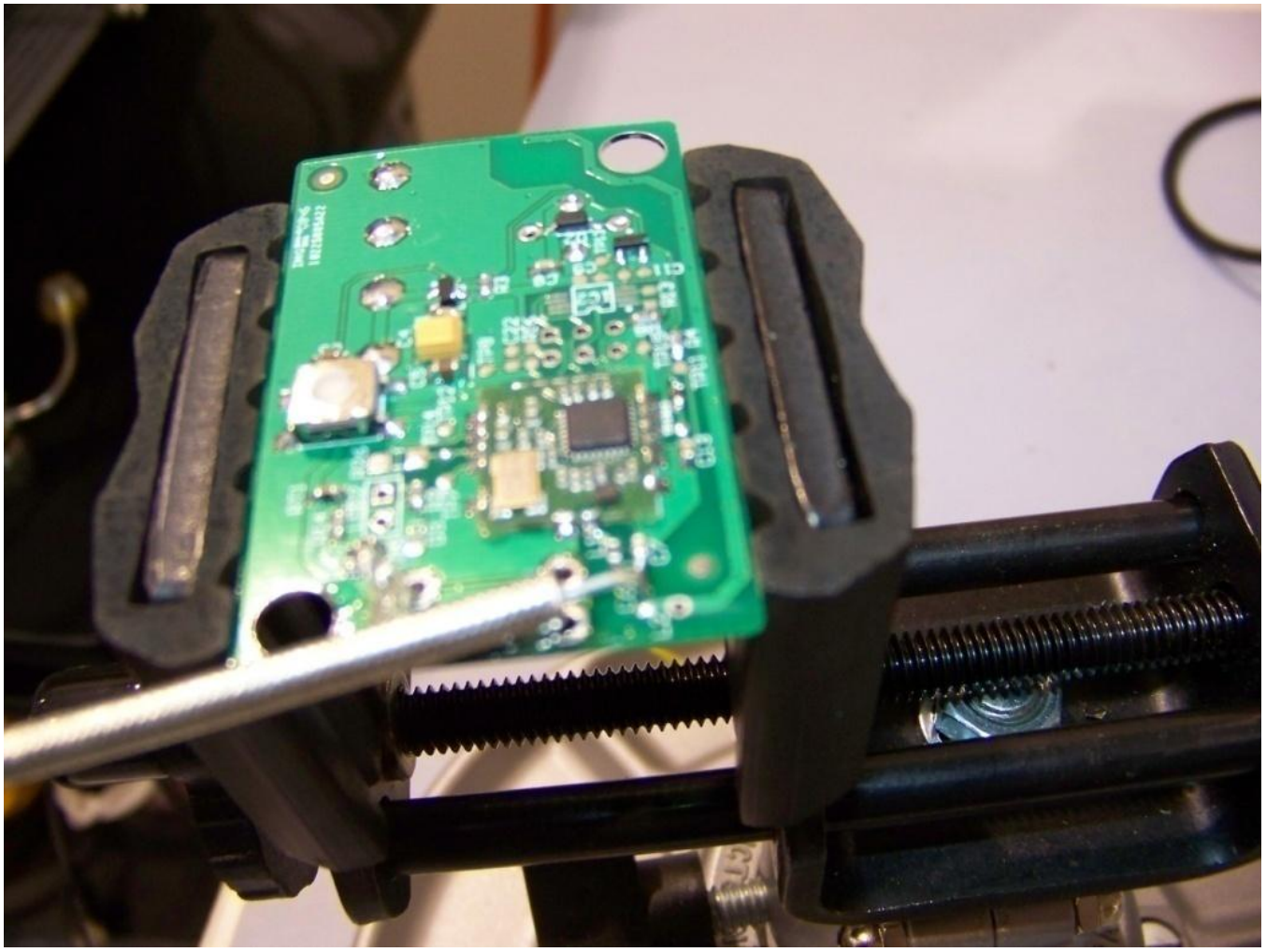


Figure 15: Close-Up View Showing the Connection Point of the Coaxial Cable Instead of the Trace Antenna

2.1.3.4 Test Procedure

The transmitter output was connected to the Spectrum Analyzer using a short RF coaxial cable. The bandwidth of the fundamental frequency was measured with the Spectrum Analyzer using 9.1 kHz RBW and VBW=91 kHz.

For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna trace of the EUT, through a short length of coaxial cable connection to the spectrum analyzer. The loss from the cable was added on the analyzer as internal correction factors, thereby allowing direct measurements, without the need for any further corrections. The EUT was configured to run in the normal operation mode, while being activated to force transmissions. The transmitter actual data, as would normally be transmitted, as a modulation source. The spectrum analyzer was used in peak-hold mode while measurements were made, as presented in the table below.

2.1.3.5 Test Results

Center Frequency	Measured Occupied Bandwidth At the -20 dBc level
908.4 (MHz)	121.6 (kHz)

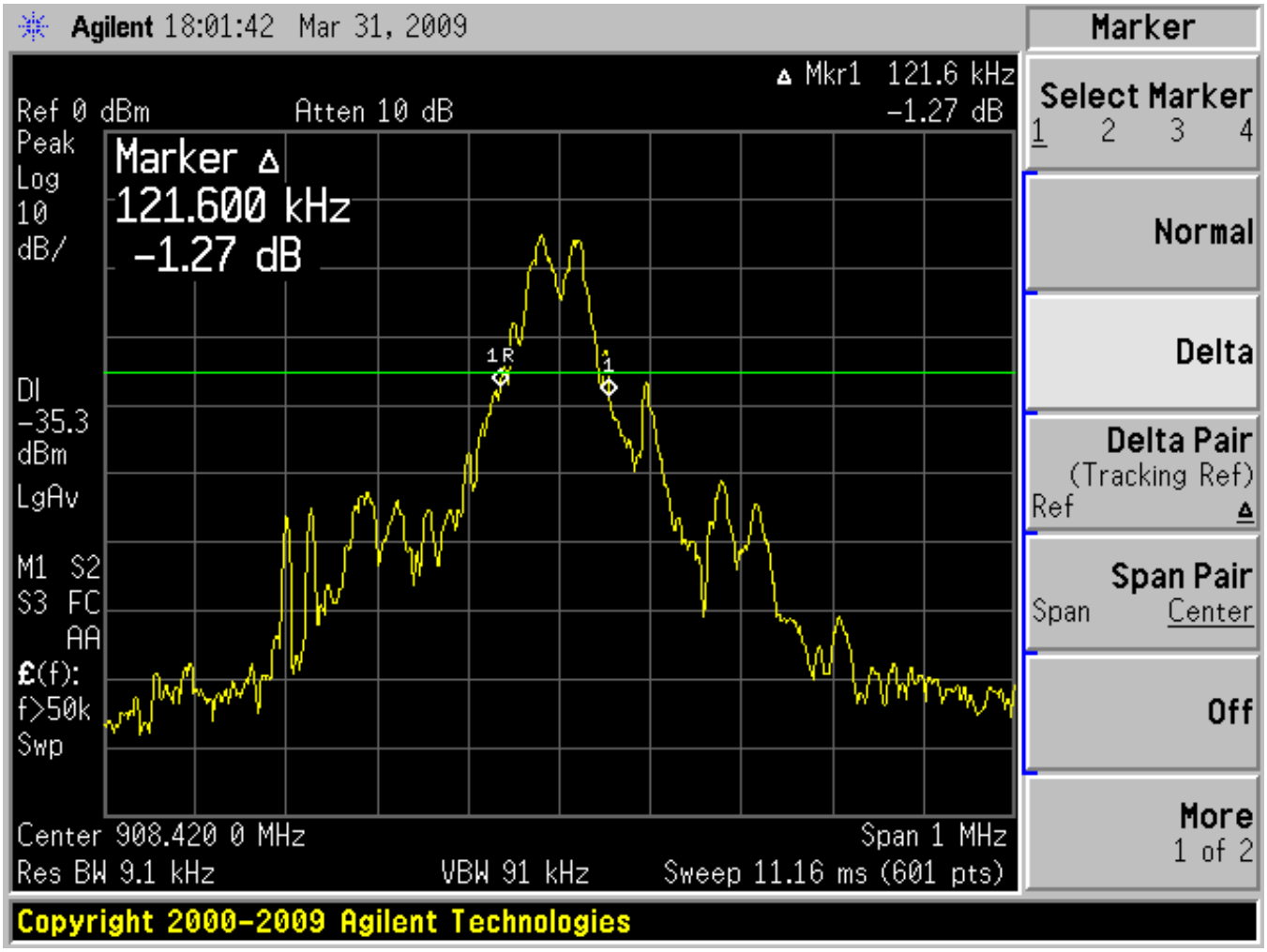


Figure 16: Transmit Occupied Bandwidth (-20dBc Level)

2.1.4 Radiated RF Performance Parameters – Band-Edge Measurements

2.1.4.1 Test Criterion

The device shall have no emissions at the band-edges, outside of the 902-928 MHz band, above the limits set forth by 47 CFR 15.209.

Frequency (MHz)	Field Strength Limit (QPD) (dBμV/m at 10m)
f < 902.0 MHz	35.5
928.0 MHz < f	35.5

2.1.4.2 Test Equipment

All equipment is calibrated according to governing standards, and is N.I.S.T. traceable. The equipment is used according to the operation manuals as provided by the manufacturers.

Table 11: List of Equipment Used:

Manufacturer	Model	Ingenium Asset Number	Description	Last Cal data	Cal due date
Agilent	E4440A	1207	PSA Spec. Analyzer	18 Dec 2008	18 Dec 2009
Agilent	N9039A	1206	Pre-Selector	23 Dec 2008	23 Dec 2009
Agilent	N5182	1208	RF Generator	18 Dec 2008	18 Dec 2009
A.H. Systems	PAM-0118	1388	Pre-Amplifier	01 Dec 2008	01 Dec 2009
ETS	3142C	1360	Hybrid Antenna	17 Mar 2008	17 Mar 2010

The data presented accounts for the antenna correction factor as well as cable loss or other corrections, and can, therefore, be entered into the database as a corrected measurement result.

2.1.4.3 Test Setup

The test setup in section 2.1.1.3, for radiated RF emission measurements, was used for the band-edge tests.

2.1.4.4 Test Procedure

The device was tested for radiated RF emissions at the band-edges. FCC 15.209(b) and 15.249(d) require a measurement of spurious emission levels to be at least 50 dB lower than the fundamental emission level, in particular at the Band-Edges where the intentional radiator operates, between 902-928 MHz. The EUT was operated in normal operation stand-by mode, and activated repeatedly for alarm transmission, with internally generated data as the modulating source. The band-edge measurements were made at the EUT and antenna polarization that provided the highest measured RF fundamental emissions.

2.1.4.5 Test Results

Frequency (MHz)	Field Strength Limit (QPD) (dBμV/m at 10m)	Measured Field Strength (dBμV/m at 10m)
f < 902.0 MHz	35.5	17.2
928.0 MHz < f	35.5	18.1

2.1.5 **Conducted RF Performance Parameters – Conducted RF Power Output Measurements**

2.1.5.1 Test Criterion

Conducted RF Power Output measurements are not required, under part 15.249, for this transmitter. The following Conducted RF Power Output measurements were made and included here for reporting purpose only.

2.1.5.2 Test Equipment

All equipment is calibrated according to governing standards, and is N.I.S.T. traceable. The equipment is used according to the operation manuals as provided by the manufacturers.

Table 12: List of Equipment Used:

Manufacturer	Model	Ingenium Asset Number	Description	Last Cal data	Cal due date
Agilent	E4440A	1207	PSA Spec. Analyzer	18 Dec 2008	18 Dec 2009
Agilent	N9039A	1206	Pre-Selector	23 Dec 2008	23 Dec 2009

The data presented accounts for the antenna correction factor as well as cable loss or other corrections, and can, therefore, be entered into the database as a corrected measurement result.

2.1.5.3 Test Setup

The test setup as described in section 2.1.3.3, for conducted RF measurements, was used for the RF output power measurements.

2.1.5.4 Test Procedure

The conducted RF output power of the EUT was measured at the trace antenna node (with the antenna disconnected from the circuit) using a short RF coaxial cable to the spectrum analyzer. The loss from the cable was added on the analyzer as internal correction factors, thereby allowing direct measurements without the need for any further corrections. The unit was configured to run in a continuous transmit CW mode. The spectrum analyzer was used with resolution and video bandwidths set to RBW = 300 kHz and VBW = 3 MHz, and a span of 1 MHz, with measurements from a peak detector presented in the chart below.

2.1.5.5 Test Results

Fundamental Frequency (MHz)	Measured RF Output Power (dBm)
908.4	-11.4

Rated RF power output (watts): **0.63 mW max.** **(-2dBm: RF IC Manufacturer)**
Measured RF Power Output (Watts): **0.07 mW**
Declared RF Power Output (Watts): **0.10 mW**

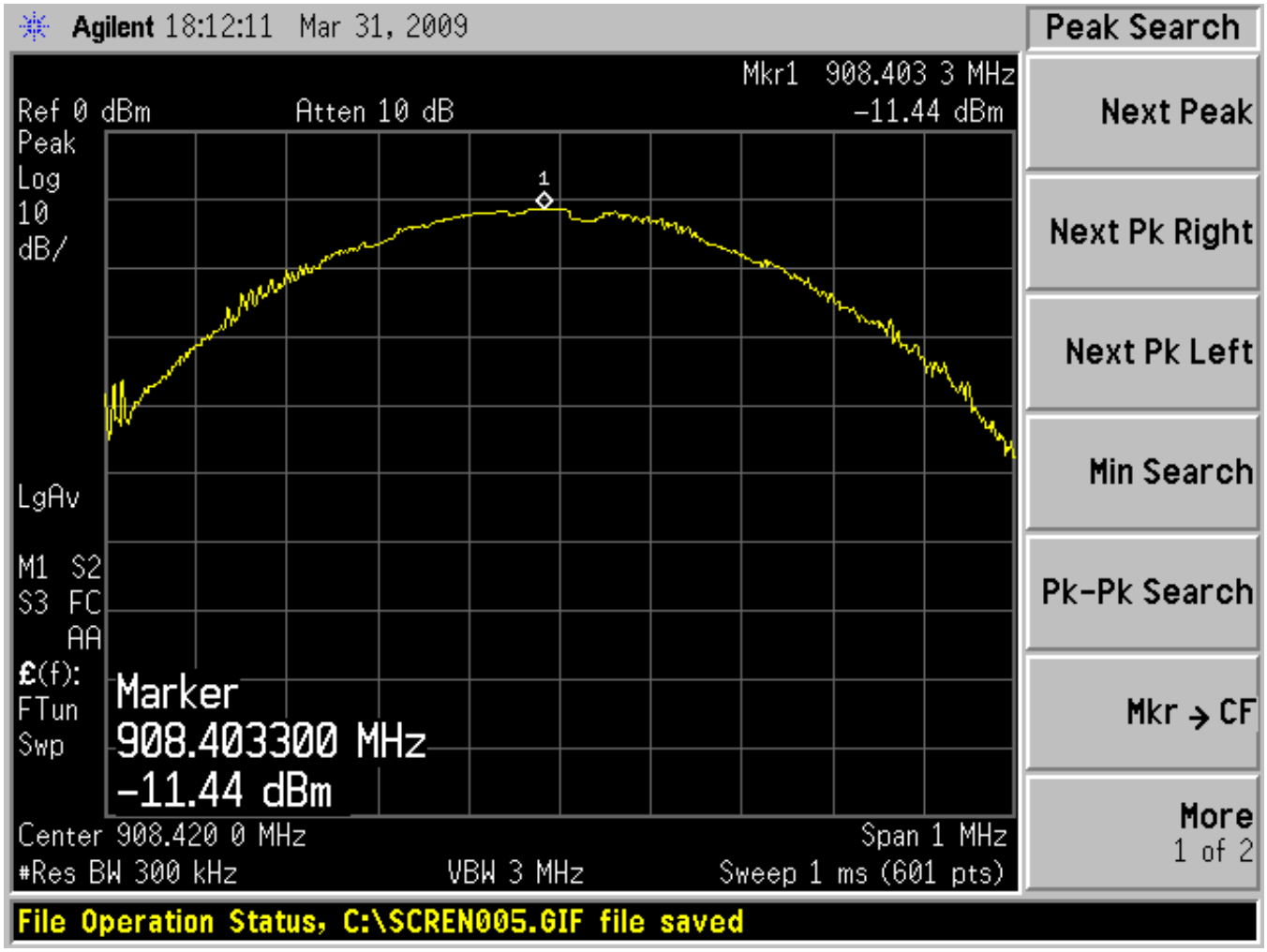


Figure 17: Transmit Conducted RF Output Power

2.1.6 Conducted RF Performance Parameters – Power Spectral Density Measurements

PSD measurements are not required for this transmitter.
No tests were performed.

2.1.7 Conducted RF Performance Parameters – Spurious RF Emission Measurements

2.1.7.1 Test Criterion

Conducted Spurious Emission measurements are not required, under part 15.249, for this transmitter. The following Conducted Spurious Emission measurements were made and included here for reporting purpose only.

The criteria stated in 47 CFR Part 15.249 (d) for radiated spurious emission limits will also be used here as a basis for assessment. Based on this criteria, in any 120 kHz bandwidth outside the frequency band in which the digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 50 dB below that in the 120 kHz bandwidth, within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

2.1.7.2 Test Equipment

All equipment is calibrated according to governing standards, and is N.I.S.T. traceable. The equipment is used according to the operation manuals as provided by the manufacturers.

Table 13: List of Equipment Used:

Manufacturer	Model	Ingenium Asset Number	Description	Last Cal data	Cal due date
Agilent	E4440A	1207	PSA Spec. Analyzer	18 Dec 2008	18 Dec 2009
Agilent	N9039A	1206	Pre-Selector	23 Dec 2008	23 Dec 2009

The data presented accounts for the antenna correction factor as well as cable loss or other corrections, and can, therefore, be entered into the database as a corrected measurement result.

2.1.7.3 Test Setup

The test setup as described in section 2.1.3.3, for conducted RF measurements, was used for the RF output power measurements.

2.1.7.4 Test Procedure

The conducted RF output power of the EUT was measured at the trace antenna node (with the antenna disconnected from the circuit) using a short RF coaxial cable to the spectrum analyzer. The loss from the cable was added on the analyzer as internal correction factors, thereby allowing direct measurements without the need for any further corrections. The unit was configured to run in a continuous transmit CW mode. The spectrum analyzer was used with resolution and video bandwidths set to RBW = 300 kHz and VBW = 3 MHz, and a span of 1 MHz, with measurements from a peak detector presented in the chart below. RBW of 300 kHz was chosen to expedite testing. In the event that any spurious signals are close to the limits, the RBW would be reduced to 120 kHz.

2.1.7.5 Test Results

No significant spurious emissions could be noted within -50 dBc of the fundamental level for this product. No harmonic emissions could be noted within -45 dBc of the fundamental level.

	Conducted Power
Spur: 489.3 MHz	-72.6 (dBm)
Fundamental	-13.7 (dBm)
2nd Harmonic	-62.5 (dBm)
3rd Harmonic	-67.9 (dBm)
4th Harmonic	-81.0 (dBm)
5th Harmonic	Note (1)
6th Harmonic	Note (1)
7th Harmonic	Note (1)
8th Harmonic	Note (1)
9th Harmonic	Note (1)
10th Harmonic	Note (1)

Notes:
(1) Measurement at system noise floor.

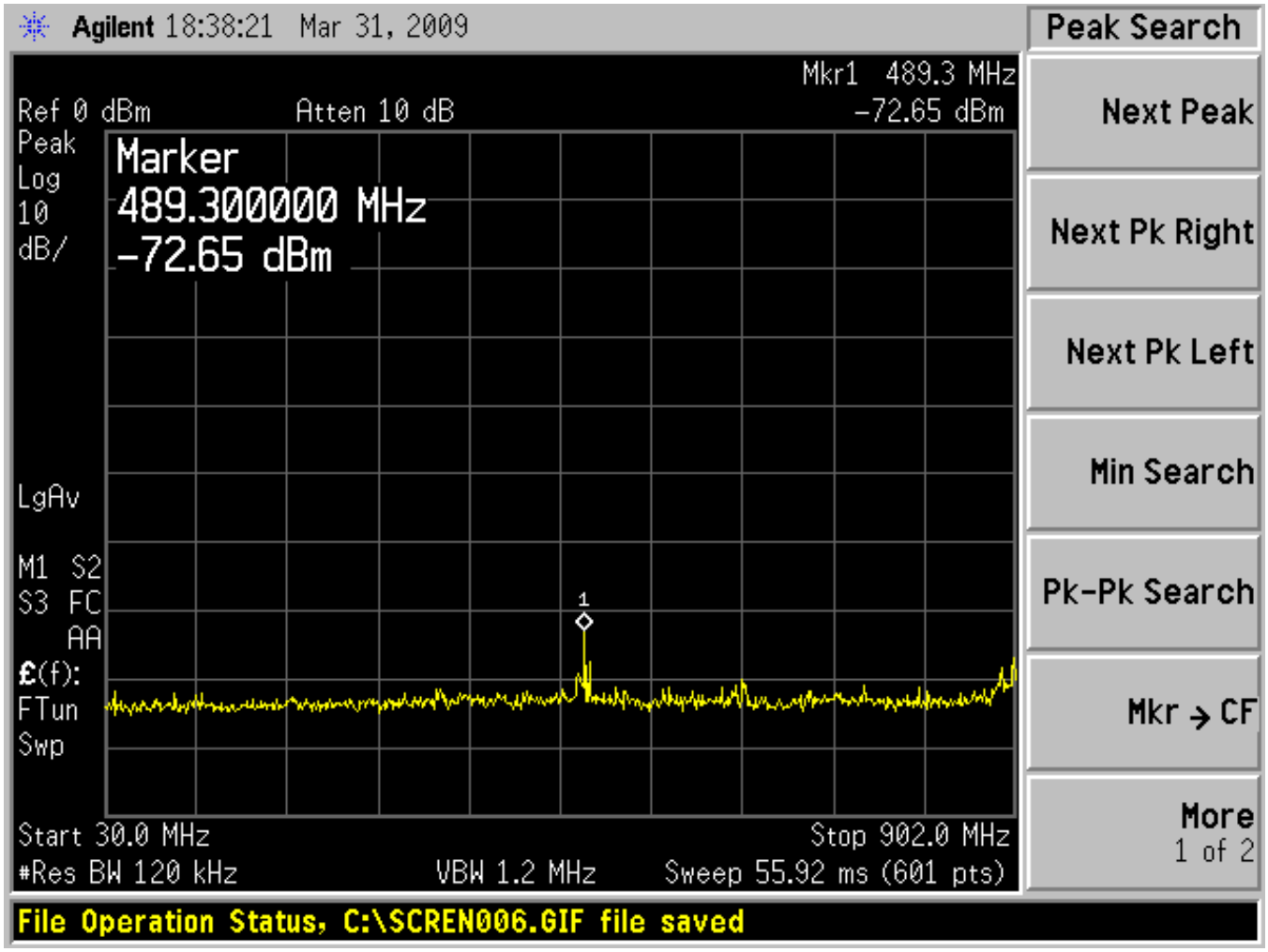


Figure 18: Transmit Conducted RF Emissions 30-902 MHz

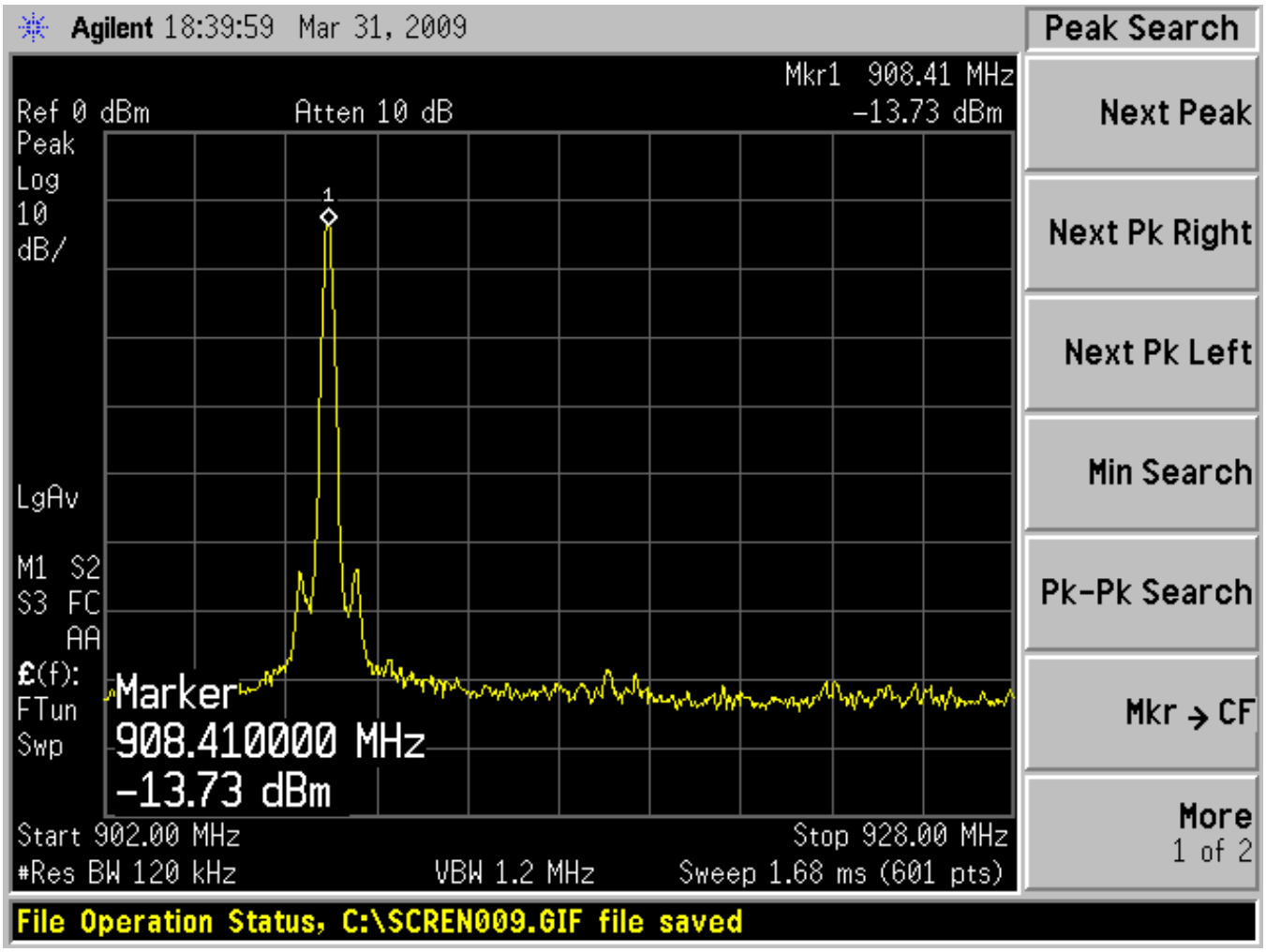


Figure 19: Transmit Conducted RF Emissions 902-928 MHz

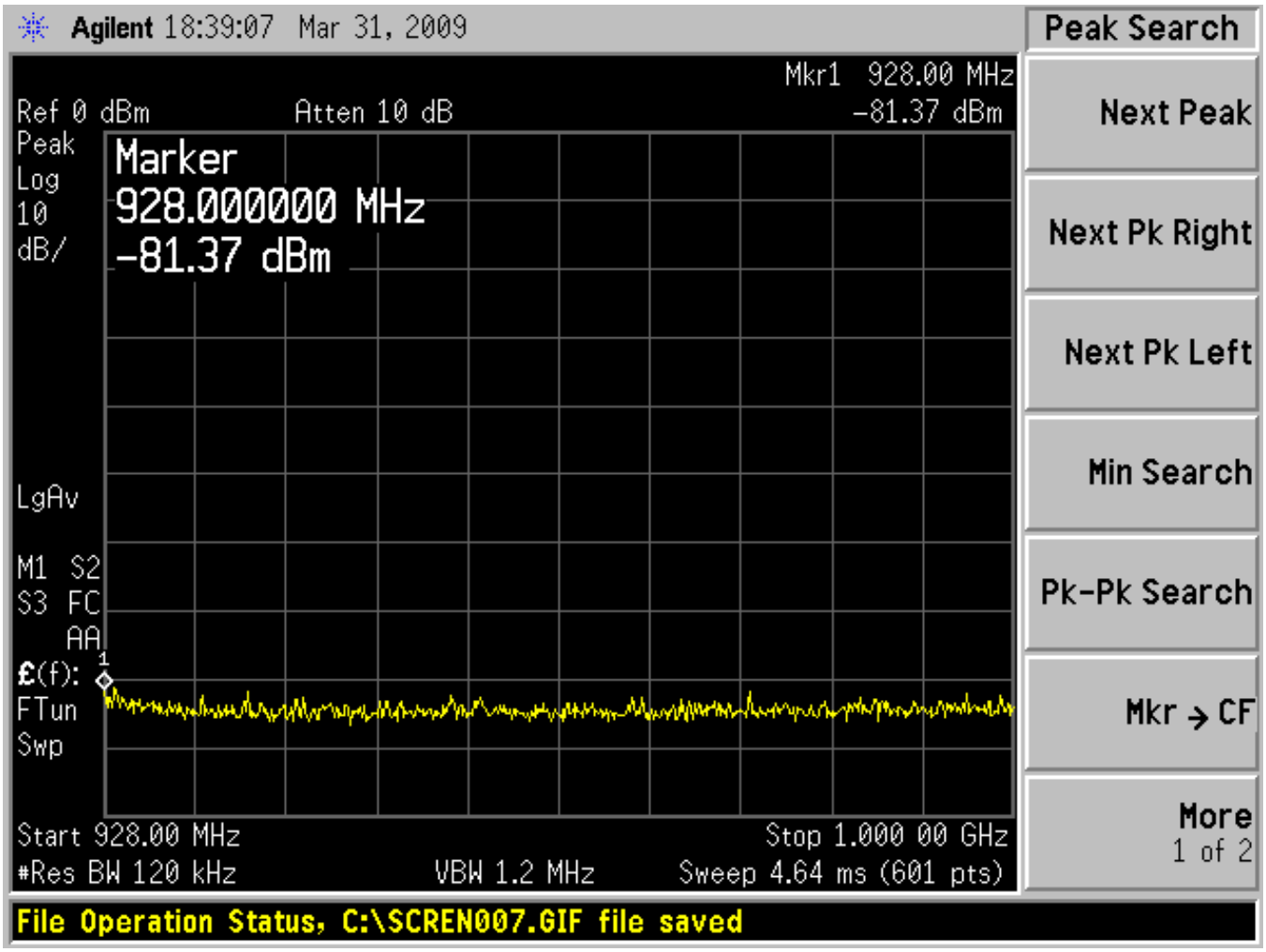


Figure 20: Transmit Conducted RF Emissions 928-1000 MHz

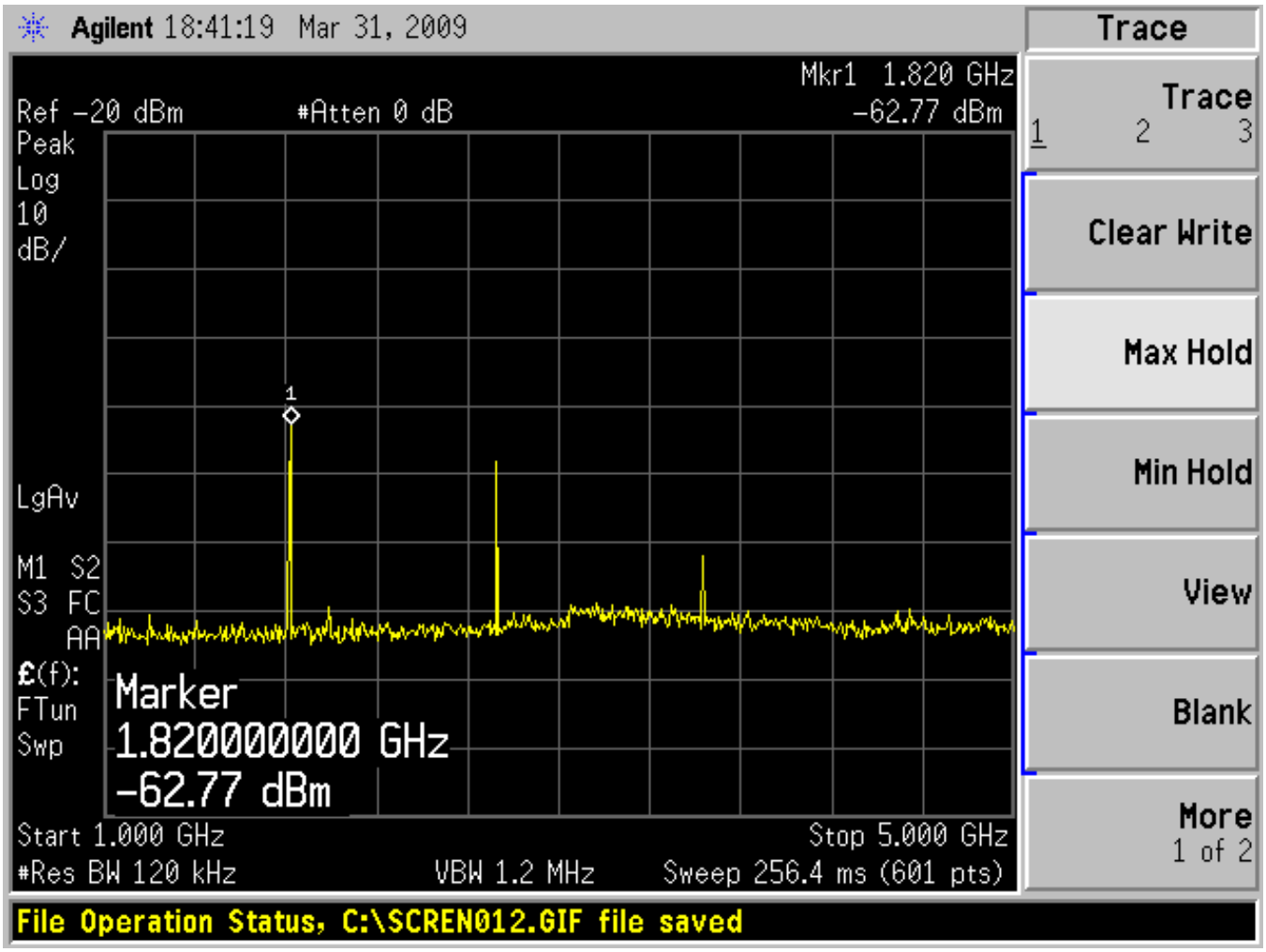


Figure 21: Transmit Conducted RF Emissions 1-5 GHz

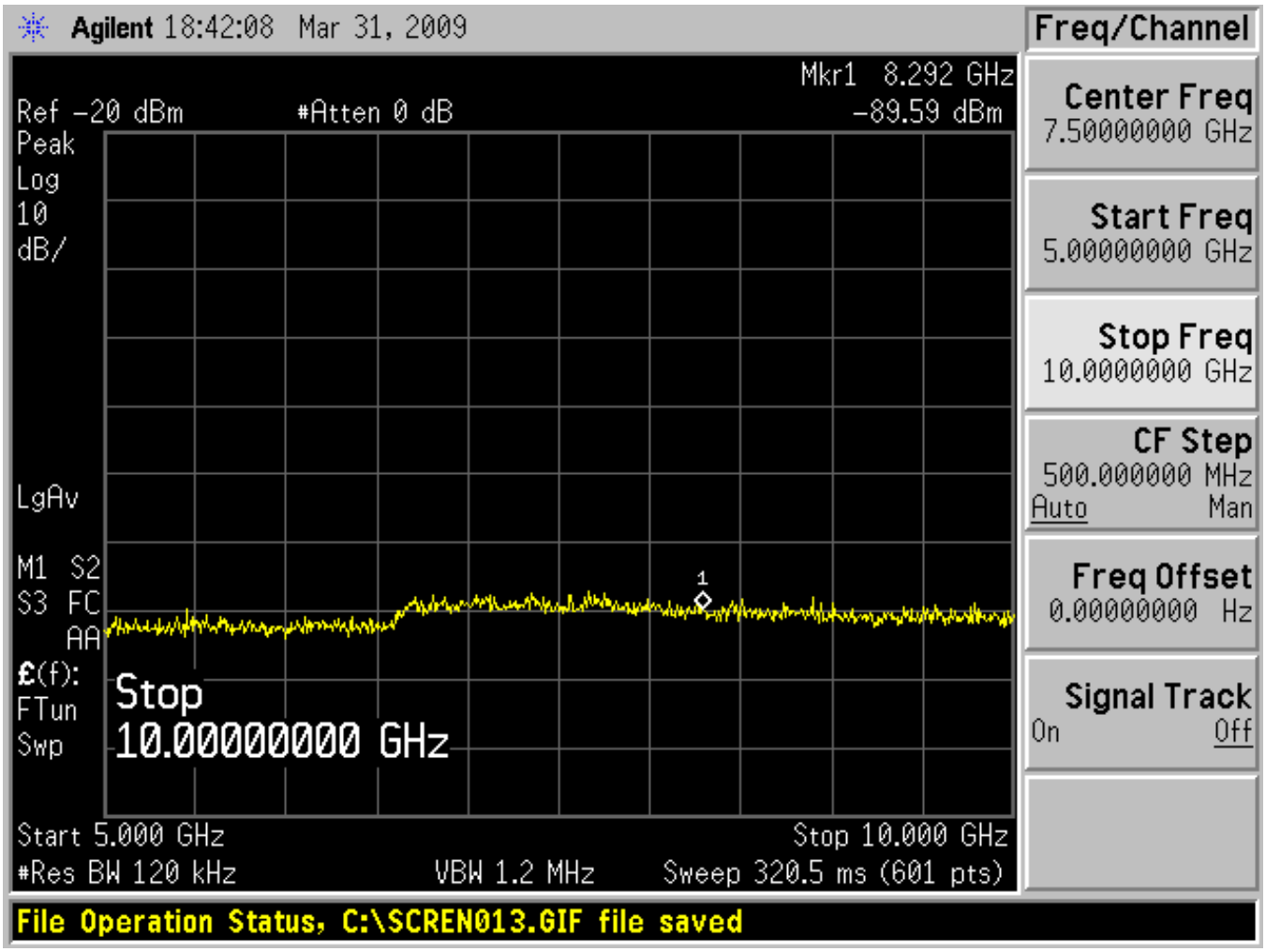


Figure 22: Transmit Conducted RF Emissions 5-10 GHz

2.1.8 **Conducted RF Performance Parameters – Carrier Frequency and RF Power Stability Measurements (Voltage and Temperature Variation)**

2.1.8.1 Test Criterion

Per 47 CFR Part 15.31(e), all intentional radiators shall be tested with a supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

Although the EUT is battery operated, and new batteries were used during tests, further tests at 85% and 115% of the nominal voltage were carried out to ensure device stability and presented here for reporting only.

2.1.8.2 Test Equipment

All equipment is calibrated according to governing standards, and is N.I.S.T. traceable. The equipment is used according to the operation manuals as provided by the manufacturers.

Table 14: List of Equipment Used:

Manufacturer	Model	Ingenium Asset Number	Description	Last Cal data	Cal due date
Agilent	E4440A	1207	PSA Spec. Analyzer	18 Dec 2008	18 Dec 2009
Agilent	N9039A	1206	Pre-Selector	23 Dec 2008	23 Dec 2009

The data presented accounts for the antenna correction factor as well as cable loss or other corrections, and can, therefore, be entered into the database as a corrected measurement result.

2.1.8.3 Test Setup

The test setup as described in section 2.1.3.3, for conducted RF measurements, was used for the RF stability measurements.

For measurements of the frequency and voltage stability, the transmitter was placed inside a temperature controlled environmental chamber. A Spectrum Analyzer was connected to the EUT through a small coaxial cable. For this test, the EUT was place inside a temperature chamber, with the transmitter portion of the EUT placed in continuous transmit CW mode. Power to the EUT was supplied by an external bench-type variable power supply. The frequency of operation was monitored using the spectrum analyzer. The power supply and spectrum analyzer were located outside the temperature chamber. The frequency was measured with a receiver resolution bandwidth of 100 kHz, and video bandwidth of 100 kHz.

2.1.8.4 Test Procedure

The stability of the device was examined as a function of the input voltage available to the EUT. For measurements of the frequency and power stability, the transmitter was placed inside a temperature controlled environmental chamber. A Spectrum Analyzer was used to measure the frequency at the appropriate frequency markers. For this test, the EUT was place inside a temperature chamber, with the transmitter portion of the EUT placed in CW continuous transmit mode. Power was supplied by an external bench-type variable power supply, and the frequency of operation was monitored using the spectrum analyzer. The power supply and spectrum analyzer were located outside the temperature chamber.

In this case, the EUT uses a single type "½ AA" battery, with a nominal voltage of 3.6 VDC. The working range of this battery is 3.8 VDC to 3.0 VDC (50% life), but the defined operation range of the EUT is limited to 3.2 VDC on the low end.

A spectrum analyzer was used to measure the frequency at the appropriate frequency markers. For this test, the EUT was placed in continuous transmit CW mode. Power to the EUT was supplied by an external bench-type variable power supply. The frequency of operation was monitored using the spectrum analyzer with RBW=VBW=100 kHz settings while the voltage was varied.

2.1.8.5 Test Results

Temperature (°C)	DC Voltage Source		
	3.06 VDC	3.60 VDC	4.14 VDC
+85	908.400 (MHz)	908.400 (MHz)	908.400 (MHz)
+25	908.400 (MHz)	908.400 (MHz)	908.400 (MHz)
-10	908.400 (MHz)	908.400 (MHz)	908.400 (MHz)

The RF Power Output of the EUT was also monitored in a separate test, also using a Spectrum Analyzer with RBW=VBW=1 MHz setting while the voltage was varied.

Temperature (°C)	DC Voltage Source		
	3.06 VDC	3.60 VDC	4.14 VDC
+85	-22. 26 (dBm)	-22.20 (dBm)	-21.55 (dBm)
+25	-22.85 (dBm)	-22.91 (dBm)	-23.06 (dBm)
-10	-21.98 (dBm)	-22.78 (dBm)	-22.82 (dBm)

The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characteristics were well behaved, and the system returned to the same state of operation as before the power cycle.

At the extreme temperature settings, a wide frequency sweep was also investigated, with minimum and maximum input voltages, to ensure that no unexpected anomalies have occurred.

No anomalies were noted in the measured transmit power, varying less than 1.6 dB, during the voltage and temperature variation tests.

2.1.9 Conducted RF Performance Parameters – MPE Calculations

2.1.9.1 Test Criterion

The following MPE calculations are based on an integrated internal printed circuit board trace monopole antenna, with a measured ERP of 65.6 dBµV/m, at 10 meters, and conducted RF power of (-)11.4 dBm as presented to the antenna. The calculated gain of this antenna, based on the ERP measurements is (-)7.7 dB.

2.1.9.2 Test Results

Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density
P = power input to the antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal:	-11.40	(dBm)
Maximum peak output power at antenna input terminal:	0.072	(mW)
Antenna gain(typical):	-7.7	(dBi)
Maximum antenna gain:	0.170	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	908.4	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.65	(mW/cm^2)
Power density at prediction frequency:	0.000002	(mW/cm^2)
Maximum allowable antenna gain:	46.5	(dBi)
Margin of Compliance at 20 cm =	54.2	dB

2.2 Electromagnetic Susceptibility Tests

There are no susceptibility requirements.
No susceptibility tests were performed on this product.

APPENDIX A: INGENIUM TESTING, LLC APPLICABLE ACCREDITATIONS

THE AMERICAN ASSOCIATION FOR LABORATORY ACCREDITATION

ACCREDITED LABORATORY

A2LA has accredited

INGENIUM TESTING, LLC

Rockford, IL

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General Requirements for the Competence of Testing and Calibration Laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 18 June 2005*).

Presented this 24th day of January 2008.

President
For the Accreditation Council
Certificate Number 2674.01
Valid to February 28, 2010

For the tests or types of tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

INGENIUM TESTING, LLC
3761 South Central Avenue
Rockford, IL 61102
James Blaha 815 315 9250 x117

ELECTRICAL

Valid To: February 28, 2010 Certificate Number: 2674.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following electromagnetic compatibility tests:

Test	Test Method
Emissions	
Radiated Emissions	47 CFR FCC Part 15.109, 209, 225, 231, 247, 249 using ANSI C63.4; 47 CFR FCC Part 18 using ANSI C63.4; FCC/OST MP-5; EN 55011; CISPR 11; AS/NZS CISPR 11; EN 55012; CISPR 12; AS/NZS CISPR 12; EN 55014-1; CISPR 14-1; AS/NZS CISPR 14-1; EN 55022; CISPR 22; AS/NZS CISPR 22; EN 61000-6-3; IEC 61000-6-3; EN 61000-6-4; IEC 61000-6-4; AS/NZS 4268+A1/A2; AS/NZS 4251-1; AS/NZS 4251-2; MIL-STD 461(E) (*Methods: RE101, RE102, RE103*); RTCA/DO160 Section 21
Conducted Emissions	47 CFR FCC Part 15.107, 207 using ANSI C63.4; 47 CFR FCC Part 18 using ANSI C63.4; FCC/OST MP-5; EN 55011; CISPR 11; AS/NZS CISPR 11; EN 55012; CISPR 12; AS/NZS CISPR 12; EN 55014-1; CISPR 14-1; AS/NZS CISPR 14-1; EN 55022; CISPR 22; AS/NZS CISPR 22; AS/NZS 4268 +A1/A2; AS/NZS 4251-1; AS/NZS 4251-2; AS/NZS 4250-1; AS/NZS 4250-2; MIL-STD 461(E) (*Methods: CE101, CE102, CE106)*; RTCA/DO160 Section 21
Harmonics	EN 61000-3-2; IEC 61000-3-2; AS/NZS 61000-3-2
Flicker	EN 61000-3-3; IEC 61000-3-3; AS/NZS 61000-3-3
Immunity	
Electrostatic Discharge (ESD)	EN 61000-4-2; IEC 61000-4-2; AS/NZS 61000-4-2; RTCA/DO160 Section 25
Electrical Fast Transient/Burst	EN 61000-4-4; IEC 61000-4-4; AS/NZS 61000-4-4
Surge Immunity	EN 61000-4-5; IEC 61000-4-5; AS/NZS 61000-4-5
Radiated	EN 61000-4-3; IEC 61000-4-3; AS/NZS 61000-4-3; MIL-STD 461(E) (*Methods: RS101, RS103*); RTCA/DO160 Section 20

Test	Test Method
Immunity (cont'd)	
Conducted	EN 61000-4-6; IEC 61000-4-6; AS/NZS 61000-4-6; MIL-STD 461(E) (*Methods: CS101, CS103, CS104, CS105, CS109, CS114, CS115, CS116*); RTCA/DO160 Section 20
Power Frequency Magnetic Field	EN 61000-4-8; IEC 61000-4-8; AS/NZS 61000-4-8; RTCA/DO160 Section 15
Pulsed Magnetic Field	EN 61000-4-9; IEC 61000-4-9
Voltage Dips/Interrupts and Variations	EN 61000-11; IEC 6100-11; AS/NZS 61000-4-11; RTCA/DO160 Section 17
Power Input	RTCA/DO160 Section 16
Audio Frequency Conducted Susceptibility Power Inputs	RTCA/DO160 Section 18
Induced Signal Susceptibility	RTCA/DO160 Section 19
Lightning Inducted Transient	RTCA/DO160 Section 22
Generic and Product Family Standards	EN 61000-6-1; IEC 61000-6-1; AS/NZS 61000-6-1; EN 61000-6-2; IEC 61000-6-2; AS/NZS 61000-6-2; CISPR 14-2; EN 55014-2; AS/NZS CISPR 14-2; CISPR 24; EN 55024; AS/NZS CISPR 24; BS EN 60601-1-2; IEC 60601-1-2; BS EN 60947-1; IEC 60947-1; BS EN 60439-1; IEC 60439-1; BS EN 61326; IEC 61326; BS EN 50130-4; BS EN 50131-1; EN 61800-3, IEC 61800-3 (limited to 75A, 1000V); BS EN ISO 14892, ISO 14892 (using component methods except ISO-7637, ISO-11452-3)
Radio	
European Union	ETSI EN 300220-1 V2.1.1; ETSI EN 300 220-2 V2.1.1; ETSI EN 300 220-3 V1.1.1; ETSI EN 300 328 V1.7.1; ETSI EN 300 328-1 V1.3.1; ETSI EN 300 328-2 V1.2.1; ETSI EN 300 330 V1.2.1; ETSI EN 300 330-1 V1.5.1; ETSI EN 300 330-2 V1.3.1; ETSI EN 300 440-1 V1.3.1; ETSI EN 300 440-2 V1.1.2; ETSI EN 301 489-1 V1.7.1; ETSI EN 301 489-3 V1.4.1; ETSI EN 301 489-17 V1.3.1;
Canada	RSS-119; RSS-210; RSS-243; ICES-001; ICES-002; ICES-003
Telecommunications	47 CFR FCC Parts 2, 90, 95.628

FEDERAL COMMUNICATIONS COMMISSION

Laboratory Division
7435 Oakland Mills Road
Columbia, MD 21046

June 12, 2008

Ingenium Testing, LLC
3761 South Central Avenue,
Rockford, IL 61102

Attention: James Blaha

Re: Accreditation of Ingenium Testing, LLC
Designation Number: US1107
Test Firm Registration #: 191720

Dear Sir or Madam:

We have been notified by American Association for Laboratory Accreditation that Ingenium Testing, LLC has been accredited as a Conformity Assessment Body (CAB).

At this time Ingenium Testing, LLC is hereby designated to perform compliance testing on equipment subject to Declaration Of Conformity (DOC) and Certification under Parts 15 and 18 of the Commission's Rules.

This designation will expire upon expiration of the accreditation or notification of withdrawal of designation.

Sincerely,

George Tannahill

rge Tannahill
tronics Engineer

END OF REPORT