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FCC PART 15.247 & IC RSS-247
900MHz FHSS
PERMISSIVE CHANGE
TEST REPORT

Applicant	VERDANT ENVIRONMENTAL TECHNOLOGIES
Address	5667 ROYALMOUNT AVENUE MONTREAL QUEBEC H4P 2P9 CANADA
FCC ID	KEY90164
IC	8410A-90164
Model Number	X9-RF-REC
Product Description	THERMOSTAT
Date Sample Received	2/25/2016
Final Test Date	4/21/2016
Tested By	Cory Leverett
Approved By	Tim Royer

Report Number	Version Number	Description	Issue Date
370AUT16TestReport	Rev1	Initial Issue	5/2/2016
370AUT16TestReport	Rev2	Updated Operating Frequency	5/8/2016

**THE ATTACHED REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL
WITHOUT THE WRITTEN APPROVAL OF TIMCO ENGINEERING, INC.**

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GENERAL REMARKS

The attached report shall not be reproduced except in full without the written permission of Timco Engineering Inc.

The test results relate only to the items tested.

Summary

The device under test does:

- ☒ Fulfill the general approval requirements as identified in this test report
- ☐ Not fulfill the general approval requirements as identified in this test report

Attestations

This equipment has been tested in accordance with the standards identified in this test report. To the best of my knowledge and belief, these tests were performed using the measurement procedures described in this report.

All instrumentation and accessories used to test products for compliance to the indicated standards are calibrated regularly in accordance with ISO 17025: 2005 requirements.

I attest that the necessary measurements were made at:

Timco Engineering Inc.
849 NW State Road 45
Newberry, FL 32669

Authorized Signatory Name:

A handwritten signature in blue ink, appearing to read 'Cory Leverett', is written over a circular purple stamp. The stamp contains the text 'CORY LEVERETT' and 'TIMCO ENGINEERING, INC.' around the perimeter.

Cory Leverett
Engineering Project Manager

Date: 4/21/2016

Applicant: VERDANT ENVIRONMENTAL TECHNOLOGIES
FCC ID: XEY90164
IC: 8410A-90164
Report: 370AUT16TestReport

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GENERAL INFORMATION

EUT Specification

Regulatory Standards	FCC Title 47 CFR Part 15.247 IC RSS-247 Issue 1 RSS-GEN Issue 4		
FCC ID	XEY90164		
IC	8410A-90164		
Model	X9-RF-REC		
EUT Description	THERMOSTAT		
Modulation Type	FHSS		
Operating Frequency	TX: 902.4 – 927.6 MHz	RX: 902.4 – 927.6 MHz	
EUT Power Source	<input type="checkbox"/> 110–120Vac/50– 60Hz		
	<input type="checkbox"/> DC Power		
	<input checked="" type="checkbox"/> Battery Operated Exclusively		
Test Item	<input type="checkbox"/> Prototype	<input type="checkbox"/> Pre-Production	<input checked="" type="checkbox"/> Production
Type of Equipment	<input checked="" type="checkbox"/> Fixed	<input type="checkbox"/> Mobile	<input type="checkbox"/> Portable
Antenna Connector	None (Temporary Connector Provided for Testing)		
Antenna	Copper Wire Antenna		
Test Conditions	Temperature: 24-26°C Relative humidity: 50-65%		
Measurement Standard	ANSI C63.10-2013 FCC DA 00-705 FCC Rule Part 15.31, 15.33, 15.35 RSS-GEN Issue 4		
Test Exercise	Engineering Software was used to enable the modes of operation; all modes of modulation were tested.		

Test Supporting Equipment

Device	Manufacturer	Model	S/N	Supplied By	Used For
N/A	N/A	N/A	N/A	N/A	N/A

RESULTS SUMMARY

FCC Rule Part No.	IC Standard Ref.	Requirement	Test Item	Result
15.247(a,1)	RSS-247 § 5.1	FHSS Requirements	20 dB Bandwidth	Pass
			Channel Separation	Pass
			Hopping Sequence	Pass
			System Receiver Bandwidth	Pass
			Number of Hopping Channels	Pass
			Hopping Channel Occupancy Time	Pass
15.247(b,1) & (b,4)	RSS-247 § 5.4.2	Peak Power Output	Peak Power Output (ERP)	Pass
			Antenna Gain (EIRP)	Pass
15.247(d)	RSS-247 § 5.5	Unwanted Emissions	Bandedge	Pass
			Radiated Spurious	Pass

Notes:

OCCUPIED BANDWIDTH

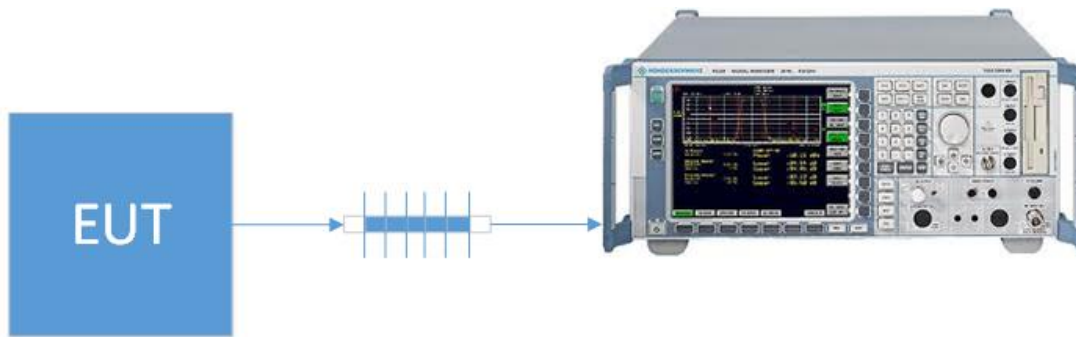
Rules Part No.: FCC 15.215(C), IC RSS 247 § 5.1.1, 5.1.1.3

FCC Requirements: The 20 dB bandwidth of the emission shall be contained within the frequency band designated in the rule section under which the equipment is operated.

IC Requirements: The maximum 20 dB bandwidth shall be 500 KHz

Test Method: ANSI C63.10 § 6.9.2 Occupied bandwidth-20dB Relative procedure

Setup:




Test Data: Mode 1 20 dB Occupied Bandwidth Measurement Table

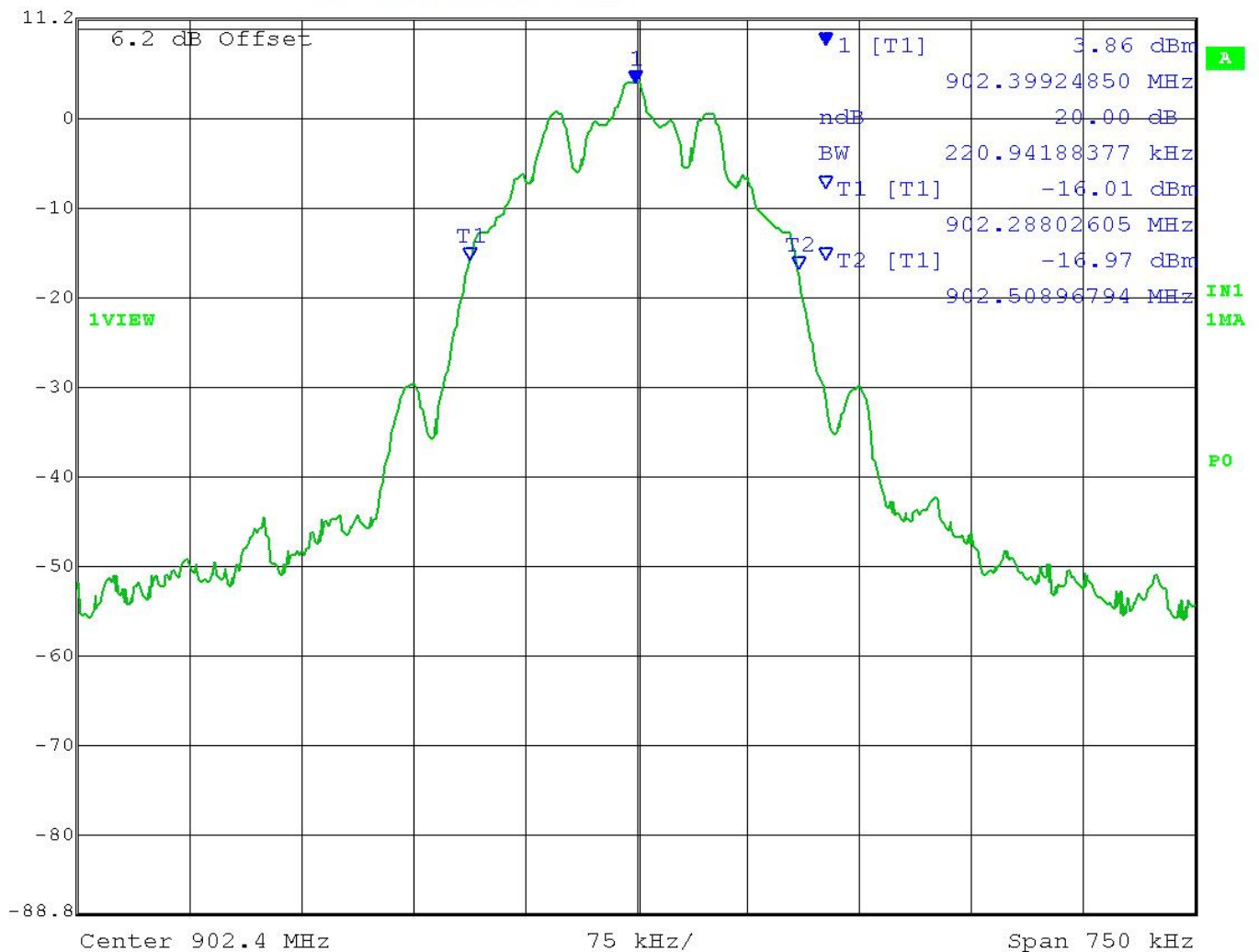
Tuned Frequency (MHz)	20 dB BW (KHz)	Limit (KHz)	Margin (KHz)
902.4	220.94	≤ 500	279.06
915.0	217.93	≤ 500	282.07
927.6	216.43	≤ 500	283.57

RESULTS: Meets Requirements

OCCUPIED BANDWIDTH

Test Data: 20 dB OBW Low End of Band Plot


 Ref Lvl 11.2 dBm
 Marker 1 [T1 ndB] 20.00 dB
 BW 220.94188377 kHz
 RBW 10 kHz
 VBW 30 kHz
 SWT 19 ms
 RF Att 20 dB
 Unit dBm



Date: 18.APR.2016 09:41:31


RESULTS: Meets Requirements

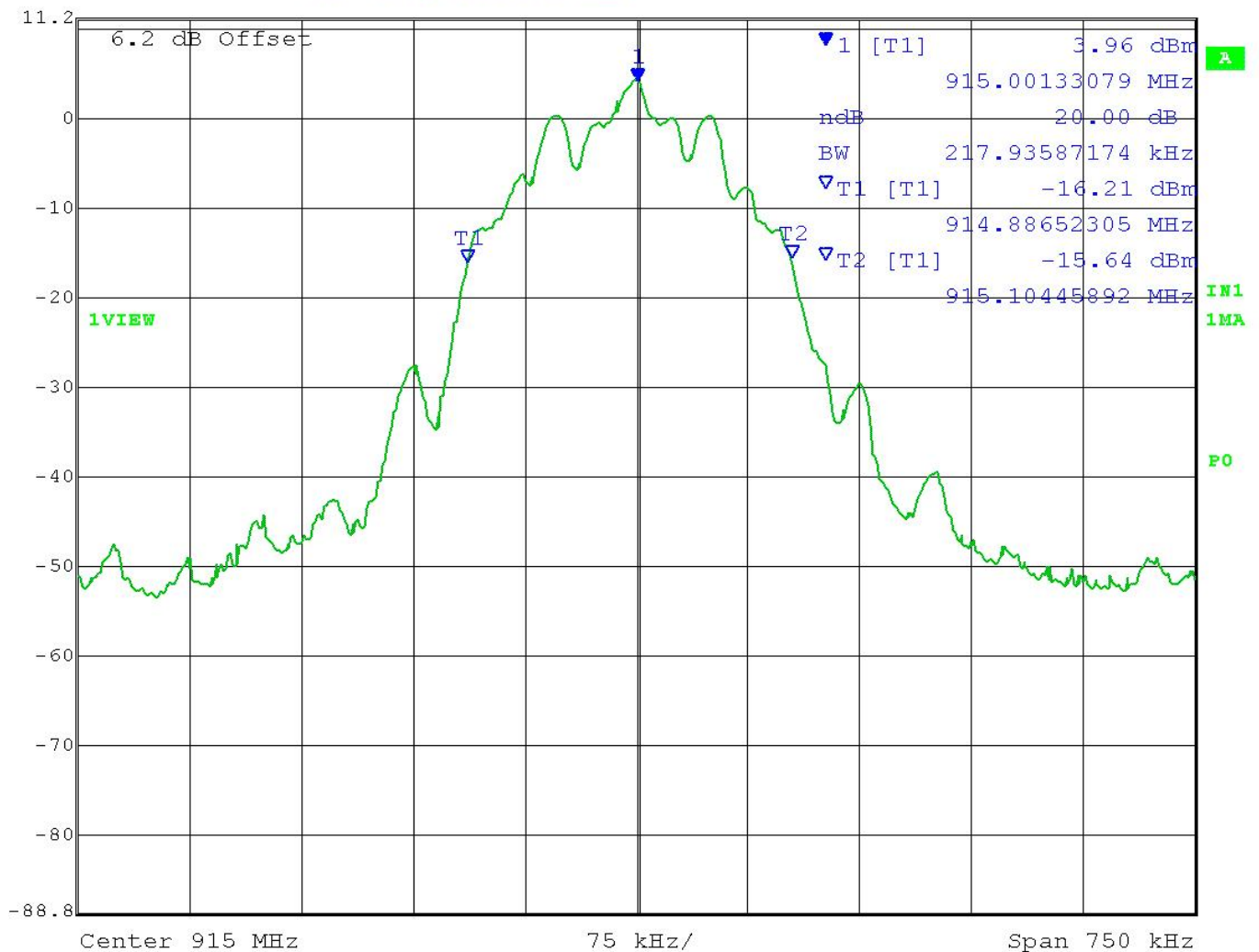
Applicant: VERDANT ENVIRONMENTAL TECHNOLOGIES
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OCCUPIED BANDWIDTH

Test Data: 20 dB OBW Middle of Band Plot


 Ref Lvl 11.2 dBm Marker 1 [T1 ndB] 20.00 dB RBW 10 kHz RF Att 20 dB
 BW 217.93587174 kHz VSWR 30 kHz Unit dBm



Date: 18.APR.2016 09:38:05


RESULTS: Meets Requirements

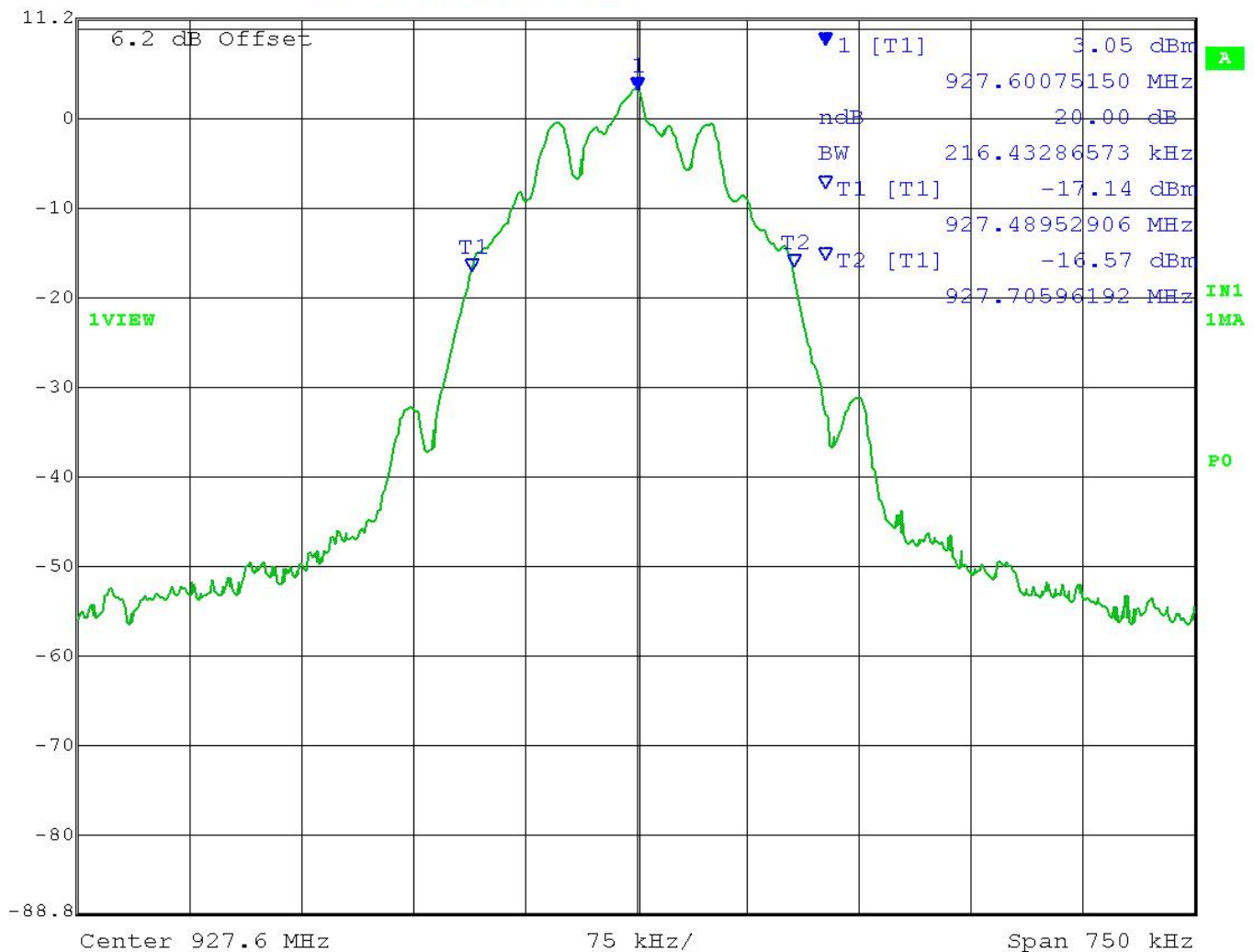
Applicant: VERDANT ENVIRONMENTAL TECHNOLOGIES
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OCCUPIED BANDWIDTH

Test Data: 20 dB OBW High end of Band Plot


 Ref Lvl 11.2 dBm
 Marker 1 [T1 ndB] 20.00 dB
 BW 216.43286573 kHz
 RBW 10 kHz
 VBW 30 kHz
 RF Att 20 dB
 SWT 19 ms
 Unit dBm



Date: 18.APR.2016 09:40:33

RESULTS: Meets Requirements

Applicant: VERDANT ENVIRONMENTAL TECHNOLOGIES
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FHSS REQUIREMENTS

Rules Part No.: FCC 15.247(a)(1), IC RSS 247 § 5.1.1, 5.1.2, 5.1.3

Requirements: **Maximum 20 dB Bandwidth**

The bandwidth of a frequency hopping channel is the -20 dB emission bandwidth, measured with the hopping stopped. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

Channel Separation

FHSS shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Dwell Time and Number of Hopping Channels

If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels

Hopping Sequence

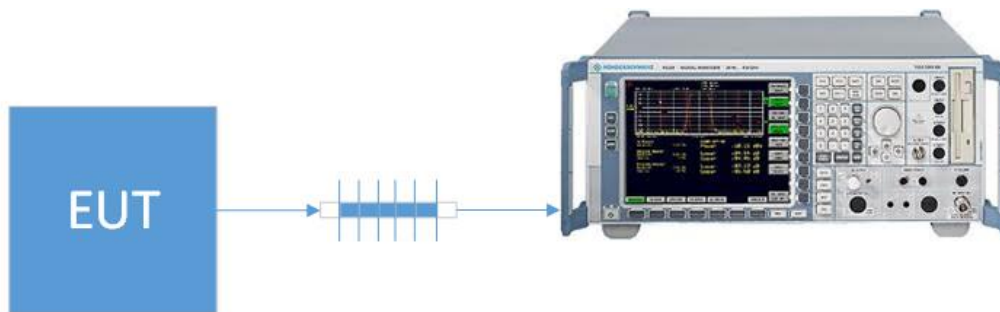
The hopset shall be such that the near-term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset, whereas the long-term distribution appears evenly distributed.

Receiver Input Bandwidth

The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Test Method: ANSI C63.10 § 7.8.2 Carrier frequency separation
 ANSI C63.10 § 7.8.3 Number of hopping frequencies
 ANSI C63.10 § 7.8.3 Time of Occupancy
 DA 00-705 § Pseudorandom Frequency Hopping Sequence
 DA 00-705 § Equal Hopping Frequency Use
 DA 00-705 § System Receiver Input Bandwidth

Setup:



FHSS REQUIREMENTS

Test Data: FHSS Channel Separation Measurement Table

Mode	Separation (KHz)	Limit (KHz)	Pass / Fail
1	400.8	≥ 147.14	Pass

Test Data: Number of Hopping Channels Measurement Table

Mode	Number of channels	Limit	Pass / Fail
1	64	≥ 50	Pass

Test Data: Hopping Channel Occupancy Time Measurement Table

Mode	Dwell Time (Sec)	Limit (sec)	Pass / Fail
1	.006	≤ 0.4	Pass

Test Data: FHSS Hopping Sequence and Receiver Bandwidth Verification

Requirement	Supporting Documentation	Pass / Fail
Pseudorandom Hopping Sequence	Operational Description provided by applicant	Pass
Equal Frequency Use		Pass
Receiver Input Bandwidth		Pass

RESULTS: Meets Requirements

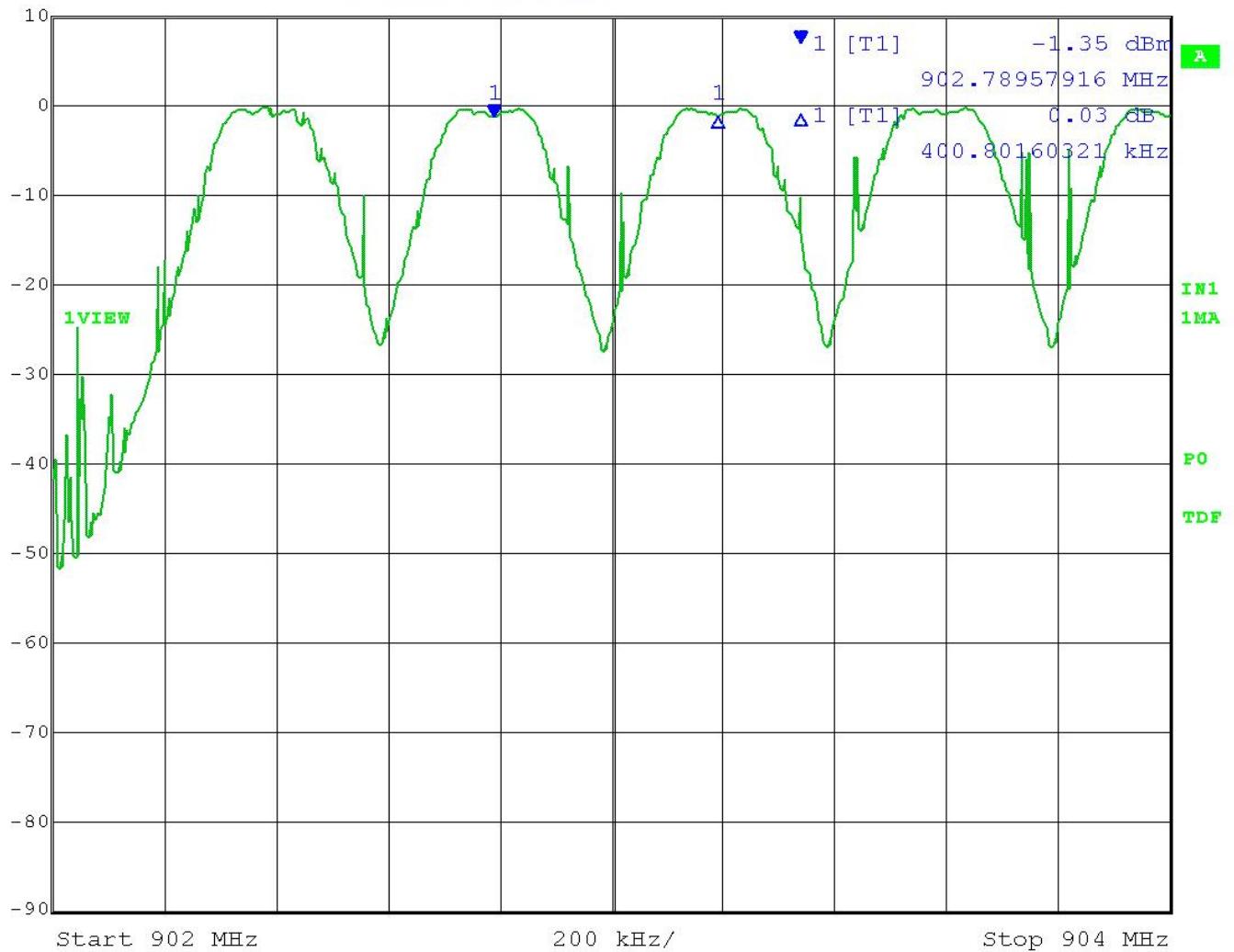
FHSS REQUIREMENTS

Test Data:

Channel Separation Plot



Ref Lvl 10 dBm
Marker 1 [T1] -1.35 dBm
902.78957916 MHz
RBW 100 kHz
VBW 300 kHz
SWT 5 ms
RF Att 30 dB
Unit dBm



Date: 20.APR.2016 16:30:24

RESULTS: Meets Requirements

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FHSS REQUIREMENTS

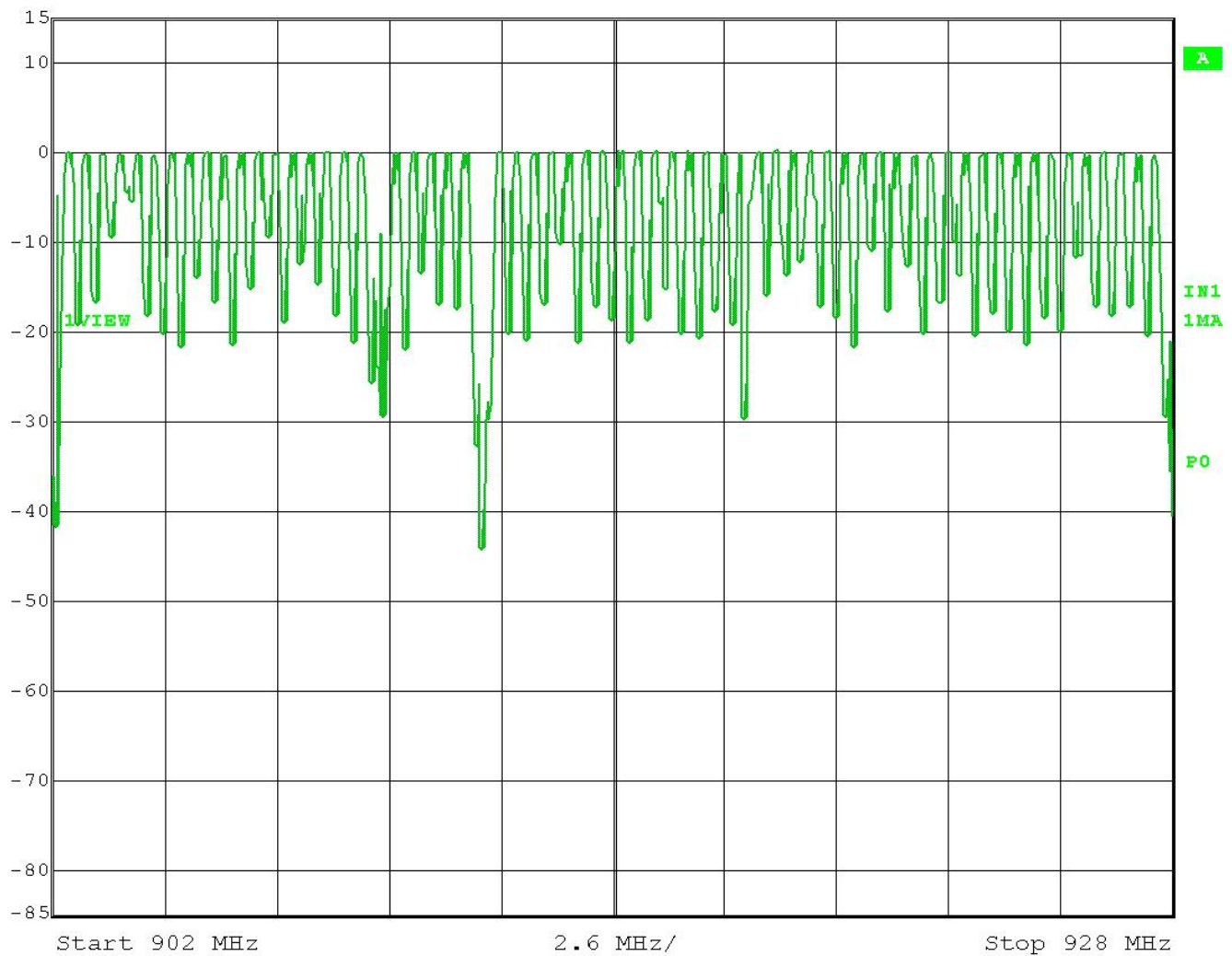
Test Data:

Number of Hopping Channels Plot



Ref Lvl
15 dBm

RBW 100 kHz RF Att 30 dB
VBW 300 kHz
SWT 120 ms Unit dBm



Date: 19.APR.2016 09:07:13

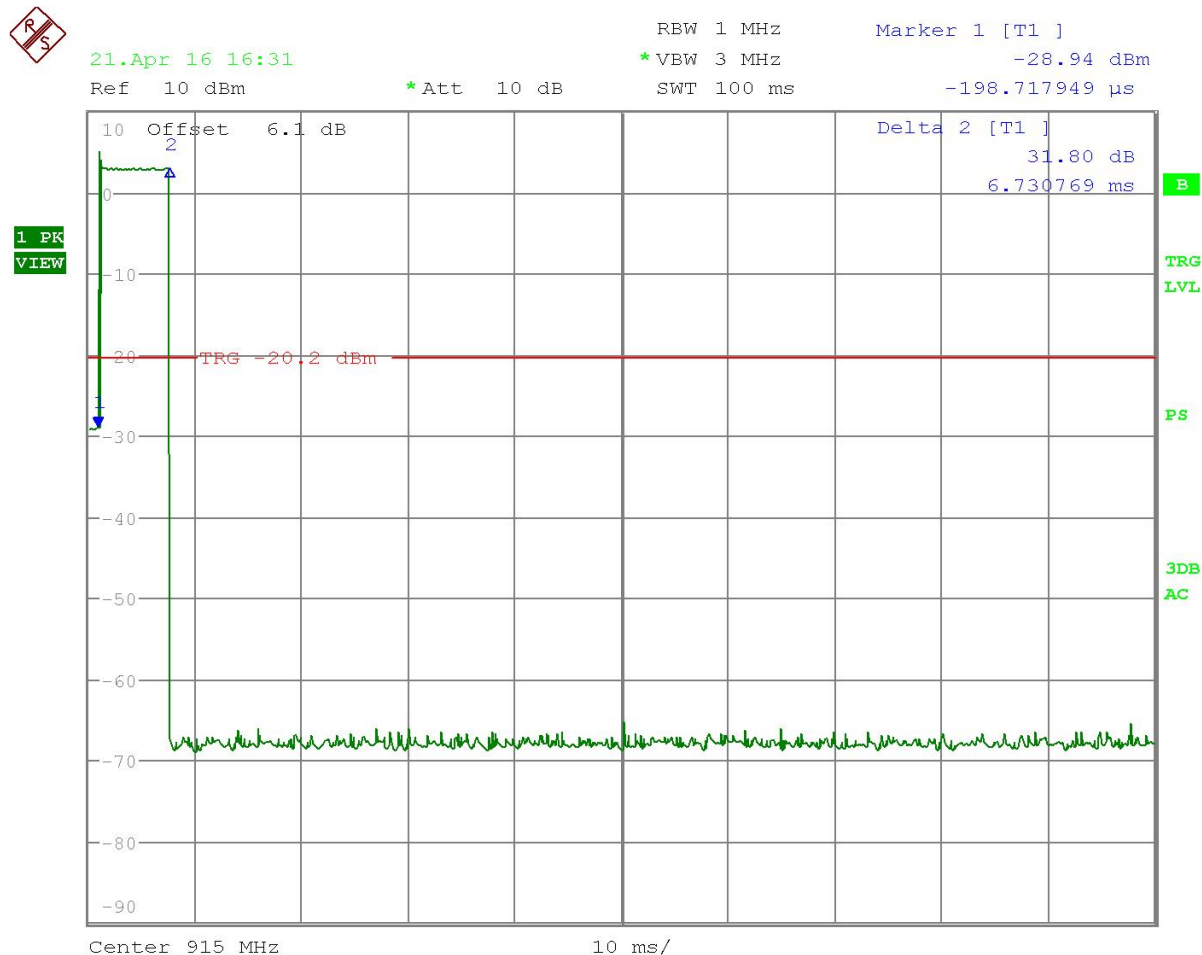
RESULTS: Meets Requirements

Applicant: VERDANT ENVIRONMENTAL TECHNOLOGIES
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FHSS REQUIREMENTS

Test Data: Channel Occupancy Time Plot



Date: 21.APR.2016 16:31:43

RESULTS: Meets Requirements

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PEAK POWER OUTPUT

Rules Part No.: FCC 15.247(b) (2) (4), IC RSS 247 § 5.4.1

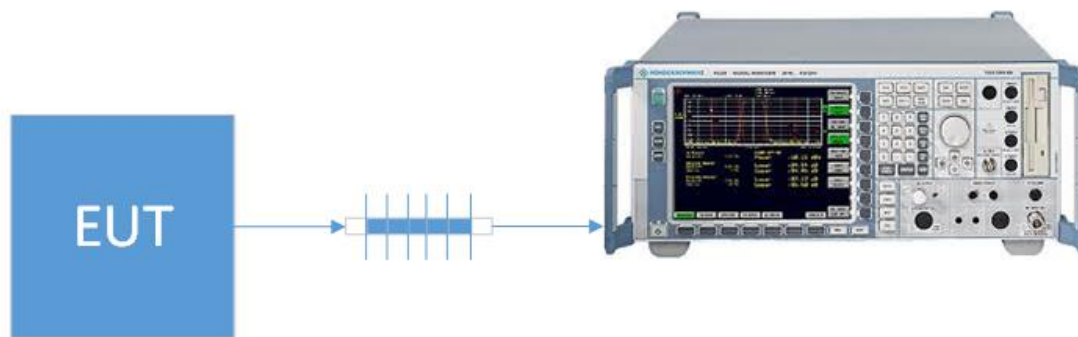
Requirements:

FHSS Using Hopset ≥ 50 Channels

The maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W if the hopset uses 50 or more hopping channels.

Test Method: ANSI C63.10 § 7.8.5 Output Power test procedure for FHSS

Setup:



PEAK POWER OUTPUT

Test Data: Peak Power Output Measurement Table

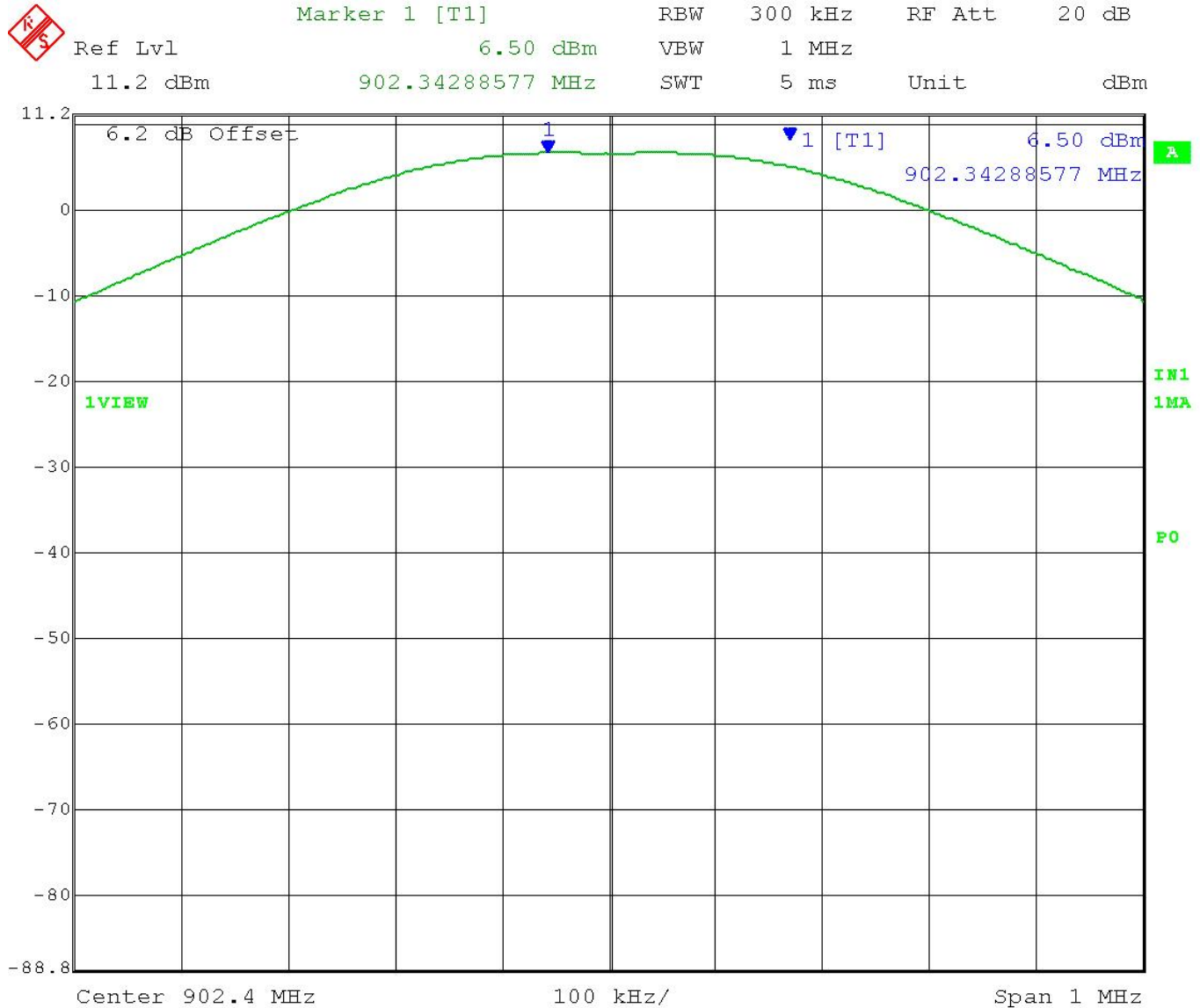
Peak Conducted Power Output Measurement				
Tuned Frequency (MHz)	Level (dBm)	ERP (W)	Limit (W)	Margin (W)
902.4	6.5	0.00447	1.00	0.99553
915	6.1	0.00407	1.00	0.99593
927.6	5.4	0.00347	1.00	0.99653

Peak EIRP Power Output Calculation				
Tuned Frequency (MHz)	ERP (dBm)	EIRP (W)	Limit (W)	Margin (W)
902.4	6.5	0.00733	4.00	3.99267
915	6.1	0.00668	4.00	3.99332
927.6	5.4	0.00569	4.00	3.99431

RESULTS: Meets Requirements

PEAK POWER OUTPUT

Test Data: Low End of Band Peak Conducted Power Plot



Date: 18.APR.2016 09:47:54

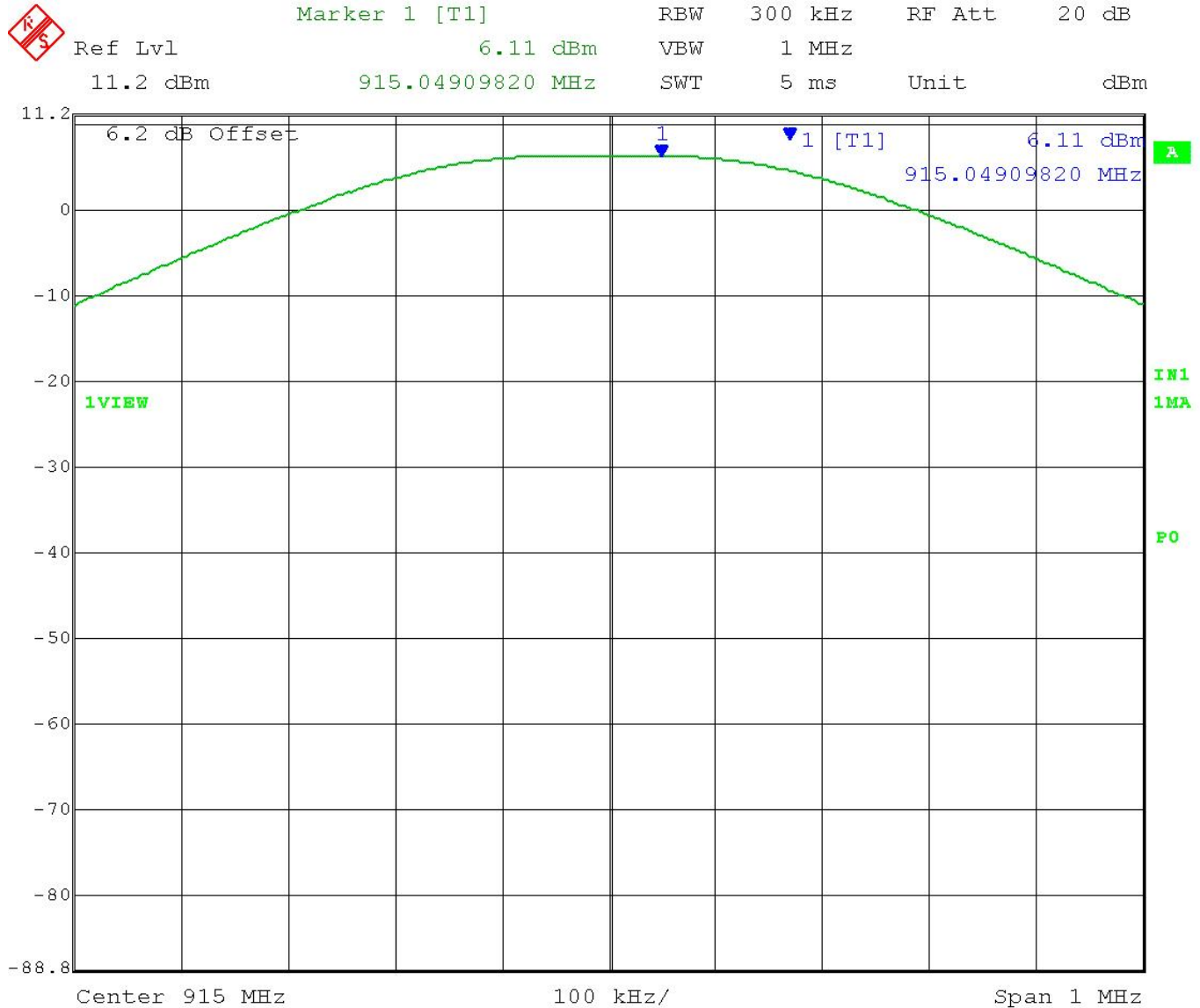
RESULTS: Meets Requirements

Applicant: VERDANT ENVIRONMENTAL TECHNOLOGIES
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PEAK POWER OUTPUT

Test Data: Middle of Band Peak Conducted Power Plot



Date: 18.APR.2016 09:50:09


RESULTS: Meets Requirements

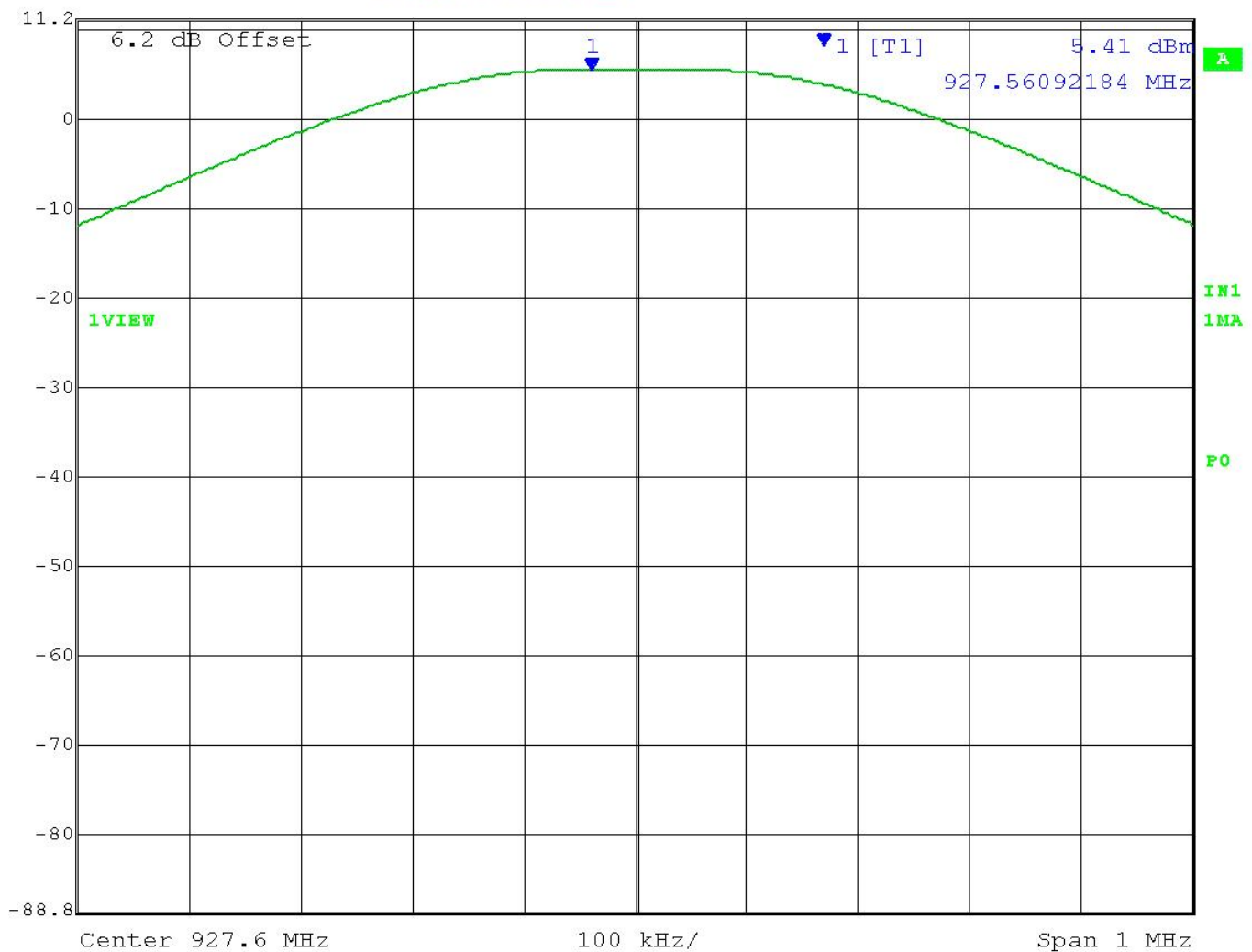
Applicant: VERDANT ENVIRONMENTAL TECHNOLOGIES
 FCC ID: XEY90164
 IC: 8410A-90164
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PEAK POWER OUTPUT

Test Data: High End of Band Peak Conducted Power Plot


 Marker 1 [T1] RBW 300 kHz RF Att 20 dB
 Ref Lvl 5.41 dBm VBW 1 MHz
 11.2 dBm 927.56092184 MHz SWT 5 ms Unit dBm



Date: 18.APR.2016 09:50:55

RESULTS: Meets Requirements

Applicant: VERDANT ENVIRONMENTAL TECHNOLOGIES
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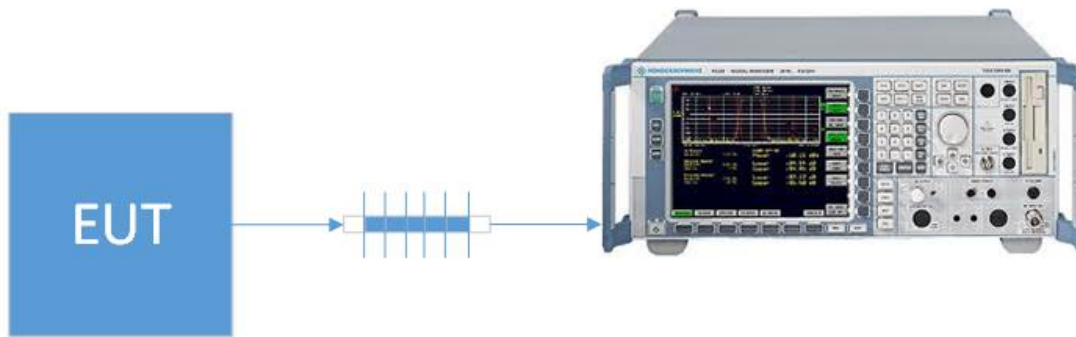
ANTENNA CONDUCTED SPURIOUS EMISSIONS

Rules Part No.: FCC part 15.247 (d), IC RSS 247 § 5.5

Requirements: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below

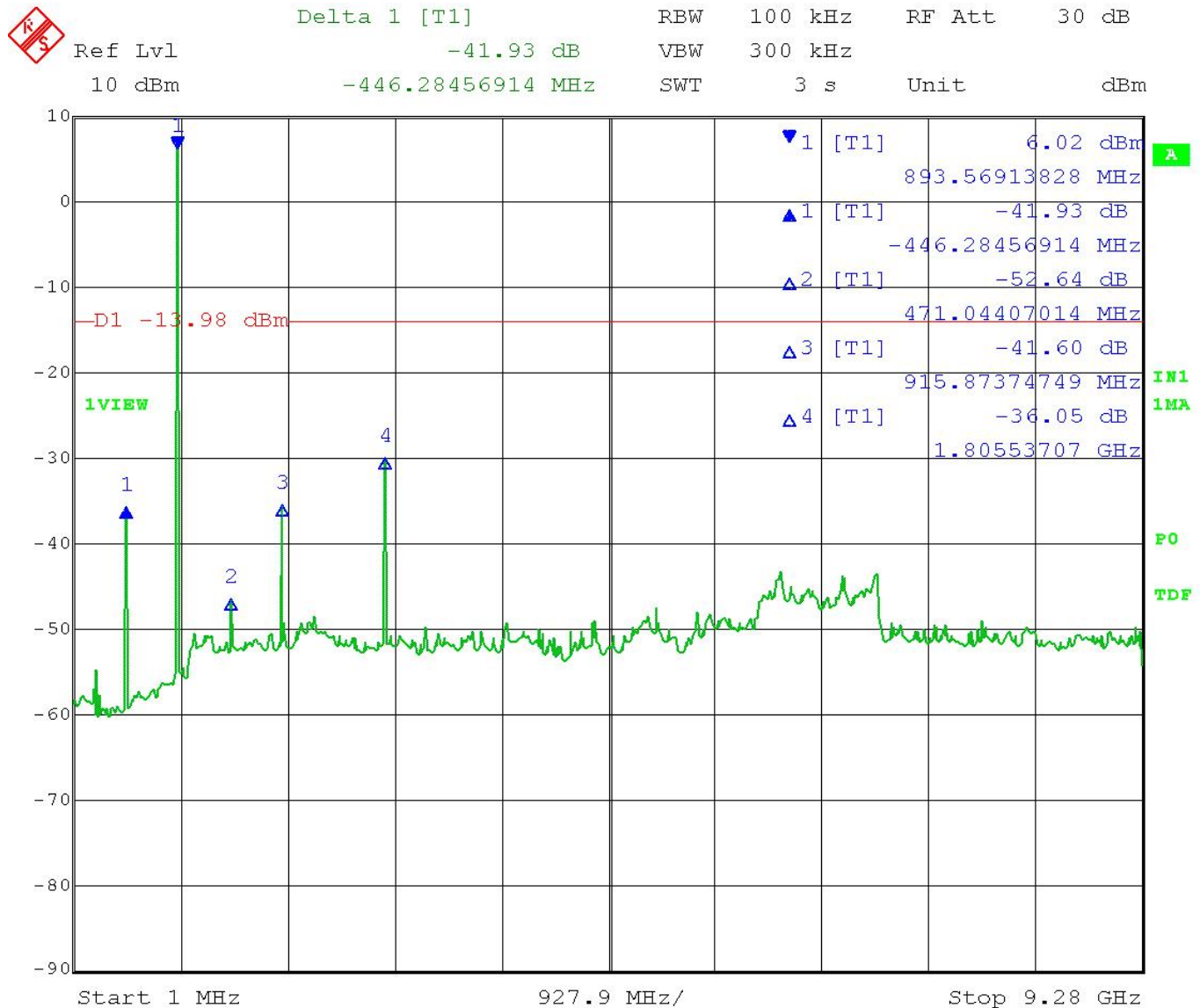
Test Method: ANSI C63.10 § 7.8.1 FHSS Device Parameters Test Setup
ANSI C63.10 § 7.8.8 Conducted spurious emissions test methodology

Setup:



ANTENNA CONDUCTED SPURIOUS EMISSIONS

Test Data: Low End of Band 30 MHz – 10 GHz Plot



Date: 18.APR.2016 14:51:02

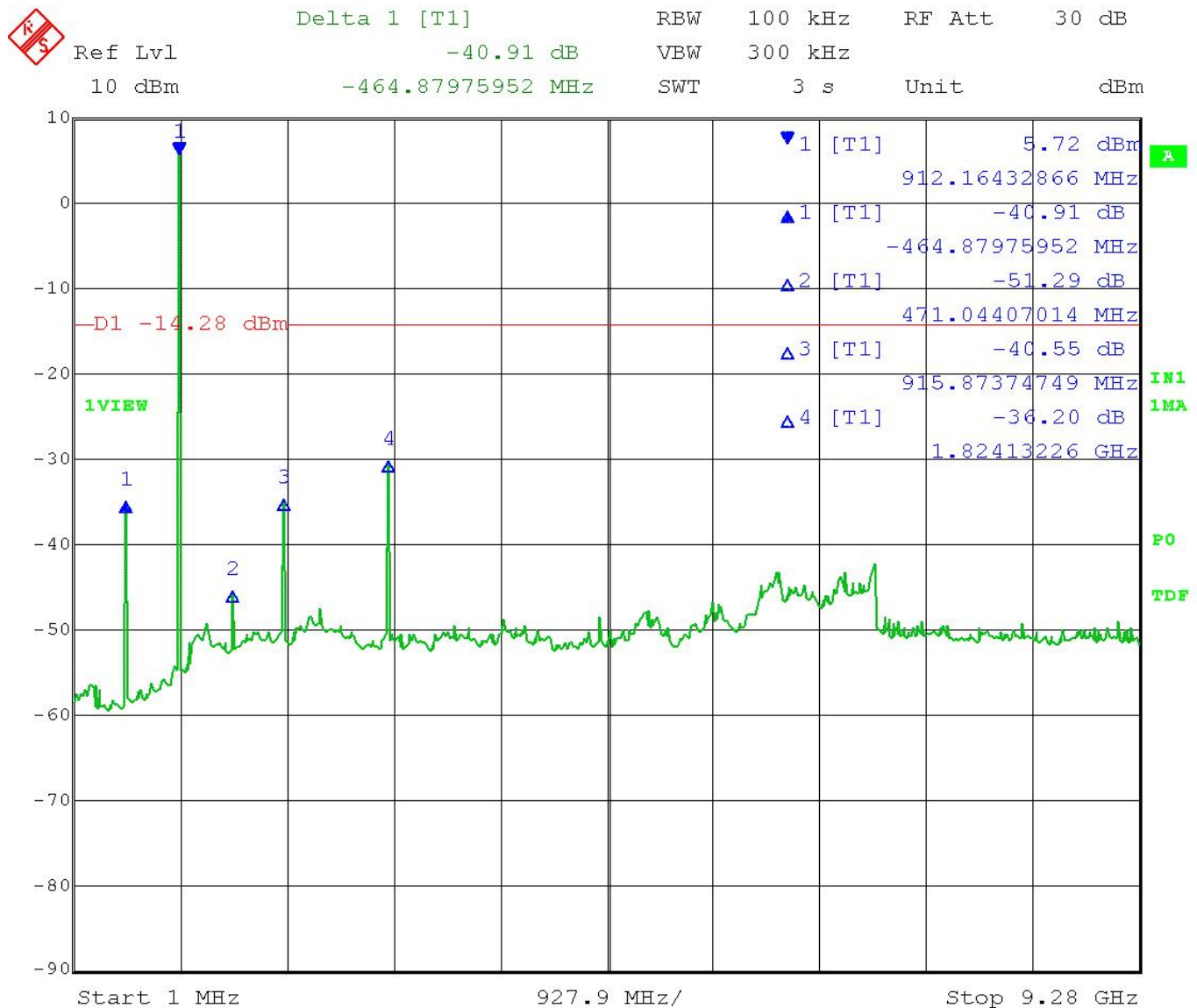
RESULTS: Meets Requirements

Applicant: VERDANT ENVIRONMENTAL TECHNOLOGIES
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ANTENNA CONDUCTED SPURIOUS EMISSIONS

Test Data: Middle of Band 30 MHz – 10 GHz Plot



Date: 18.APR.2016 14:49:49

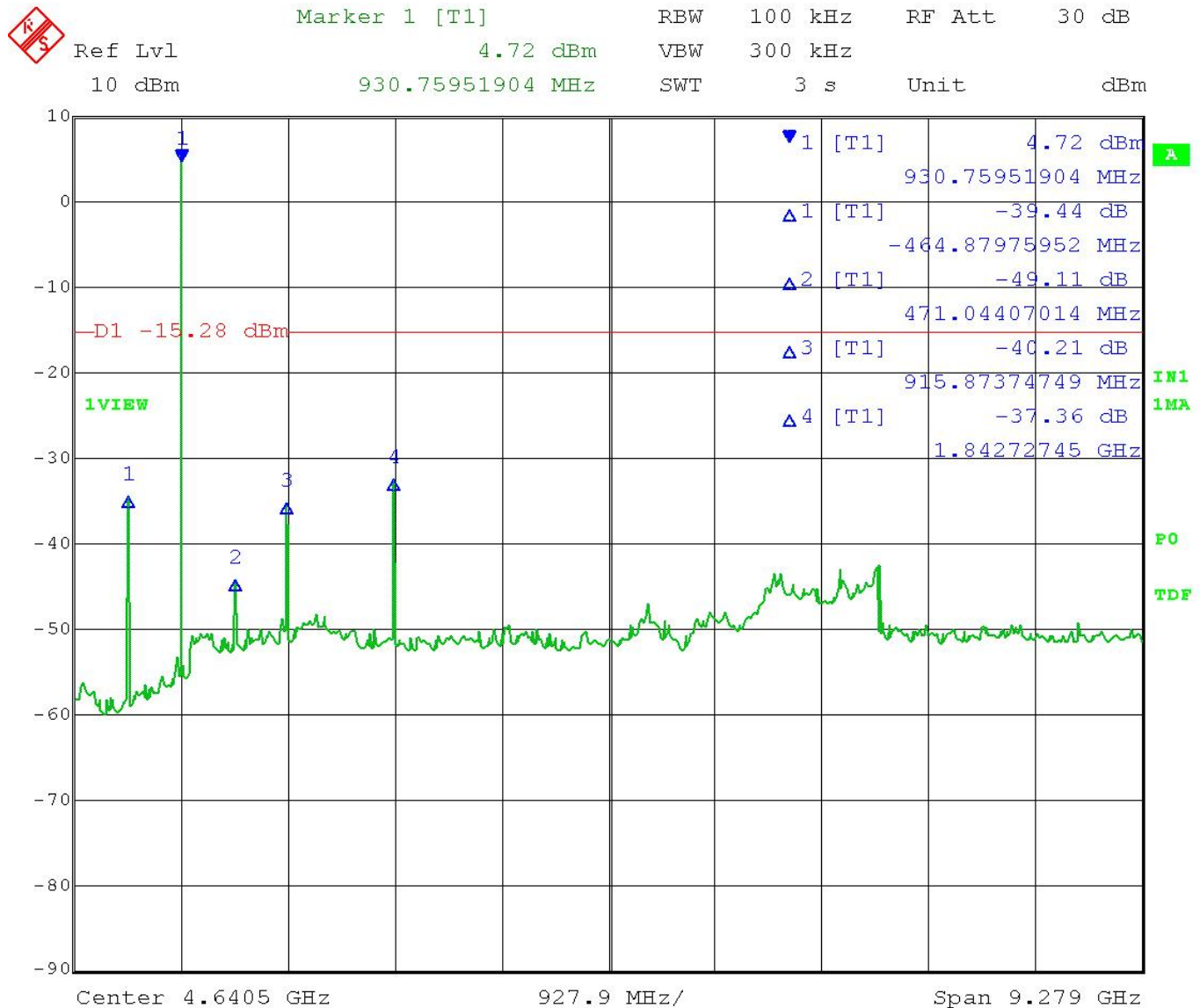
RESULTS: Meets Requirements

Applicant: VERDANT ENVIRONMENTAL TECHNOLOGIES
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IC: 8410A-90164
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ANTENNA CONDUCTED SPURIOUS EMISSIONS

Test Data: High End of Band 30 MHz – 10 GHz Plot



Date: 18.APR.2016 14:44:34

RESULTS: Meets Requirements

Applicant: VERDANT ENVIRONMENTAL TECHNOLOGIES
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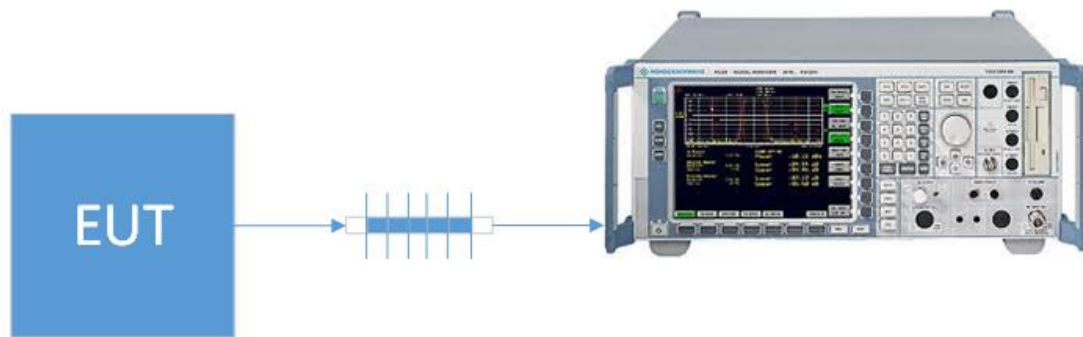
BANDEDGE

Rule Part No.: FCC 15.247(d) & 15.209, IC RSS 247 § 5.5 & RSS GEN § 8.9

Requirements: Emissions must be at least 20dB down from the highest emission level Within the authorized band as measured with a 100 kHz RBW, additionally adjacent restricted band edge emissions must comply with 15.209 and RSS-GEN 8.9 limits.

Test Method: ANSI C63.10 § 7.8.1 FHSS Device Parameters Test Setup
ANSI C63.10 § 7.8.6 Band-edge measurements for RF conducted
ANSI C63.10 § 6.10.4 Authorized band-edge relative method

Setup:



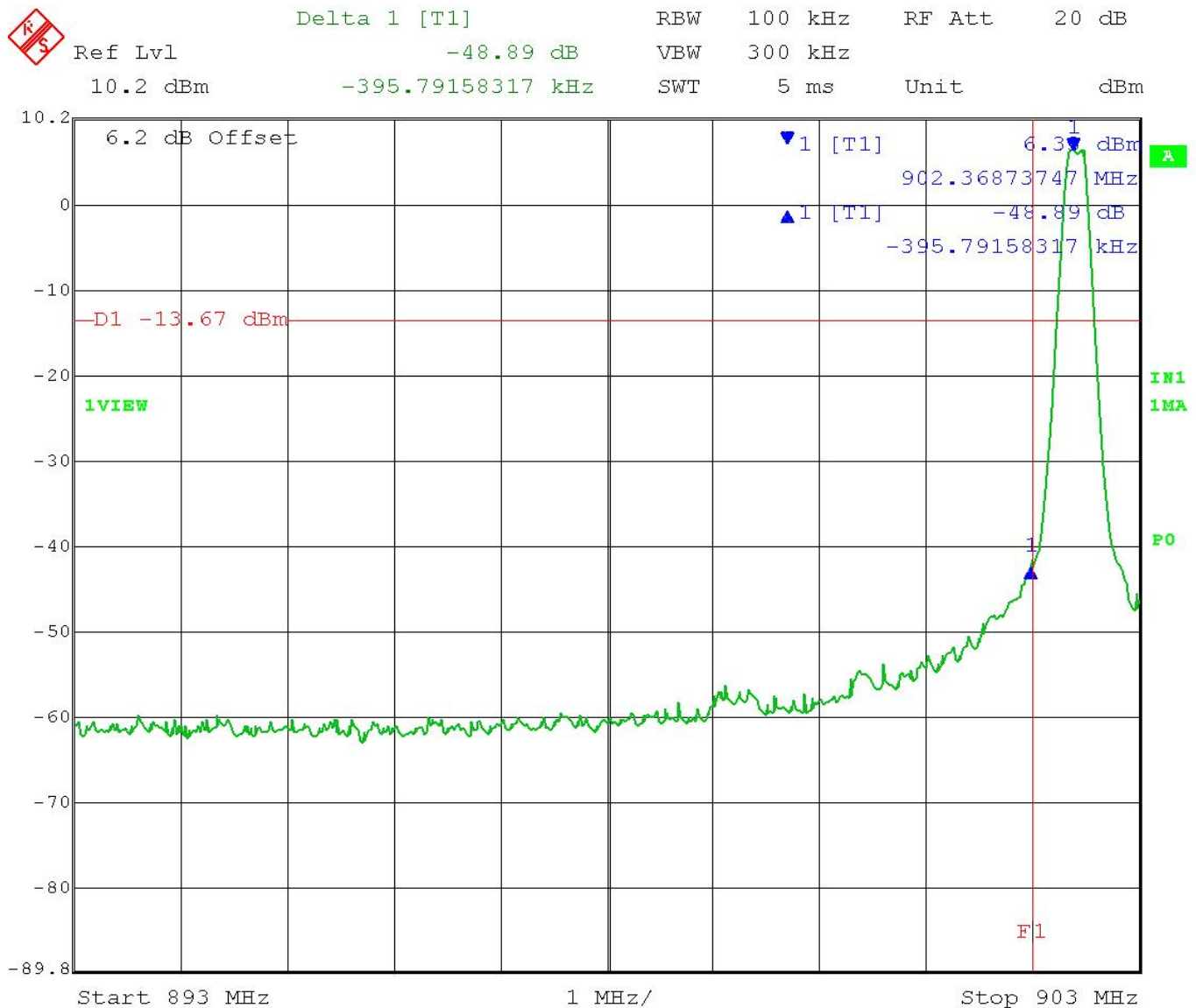
Test Data: Bandedge Measurement Table

Bandedge	Tuned Frequency (MHz)	Measured Level (dBc)	Limit (dBc)	Margin (dB)
Lower	902.4	48.89	20	20.89
	Hopping	36.2	20	16.2
Upper	927.6	50.63	20	30.63
	Hopping	34.89	20	14.89

Results Meet Requirements

BANDEDGE

Test Data: Low End of Band Lower Band Edge Plot



Date: 18.APR.2016 10:23:35

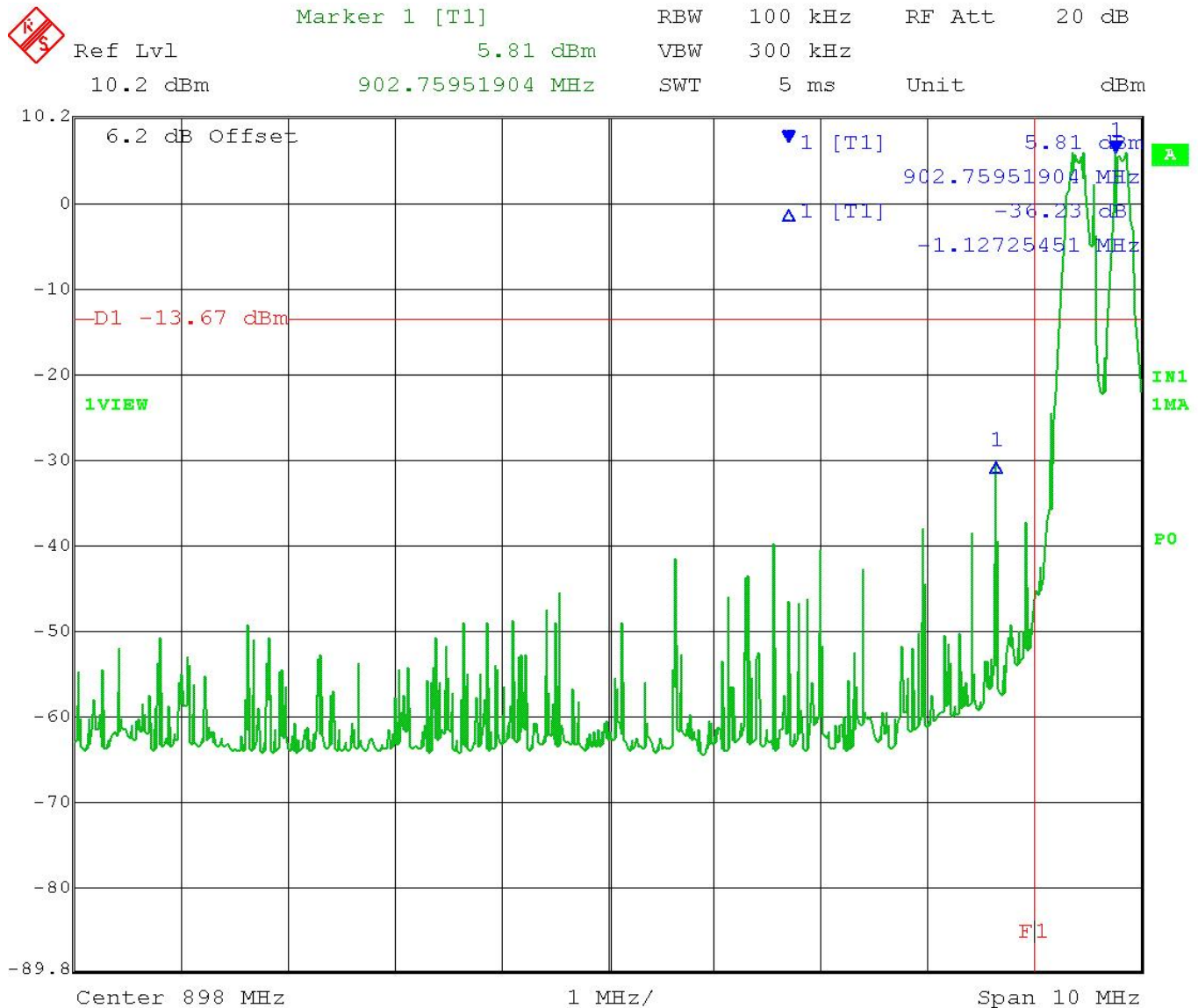
RESULTS: Meets Requirements

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BANDEDGE

Test Data: Hopping Lower Band Edge Plot



Date: 18.APR.2016 11:16:43

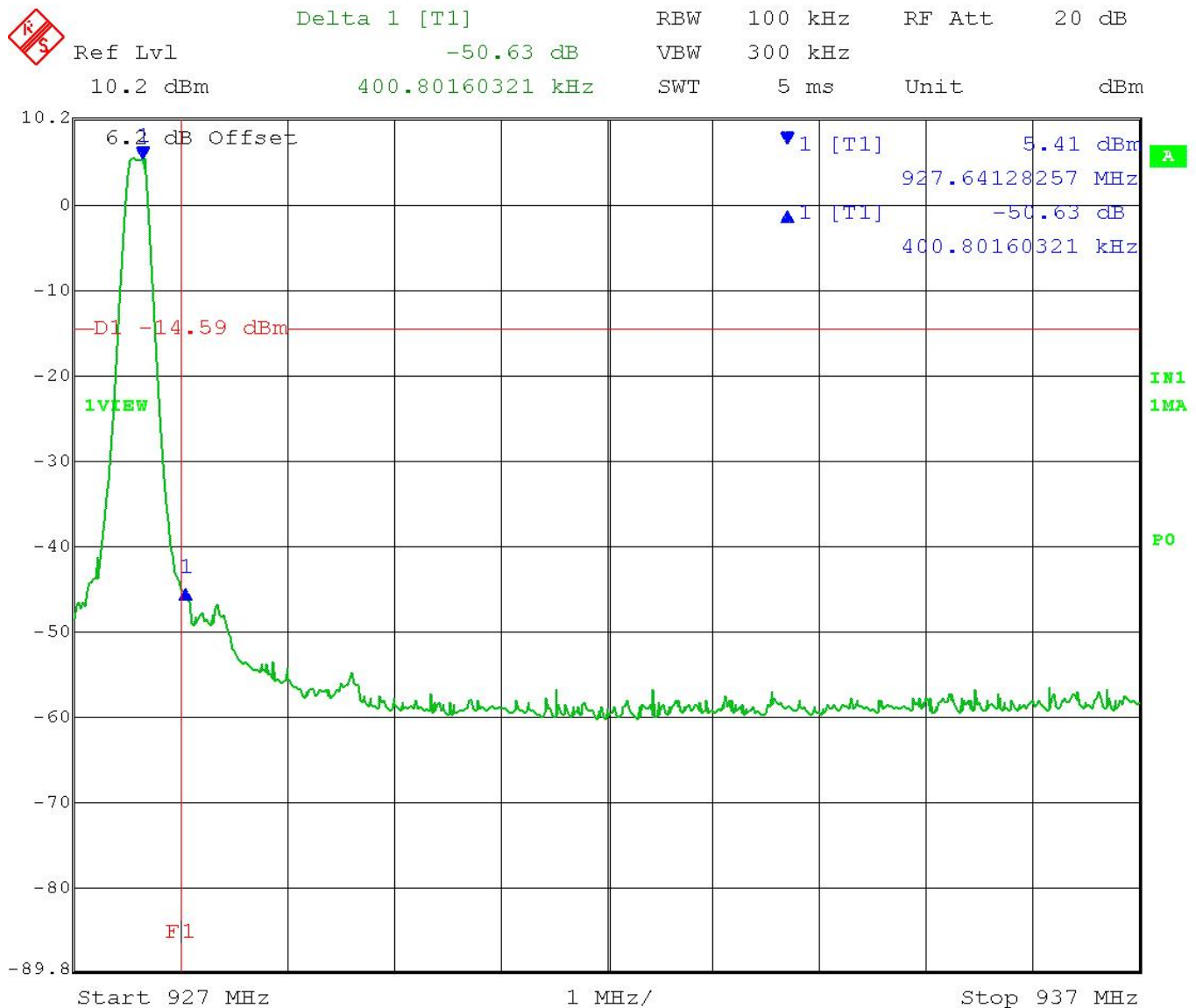
RESULTS: Meets Requirements

Applicant: VERDANT ENVIRONMENTAL TECHNOLOGIES
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BANDEDGE

Test Data: High End of Band Upper Band Edge Plot



Date: 18.APR.2016 11:21:51

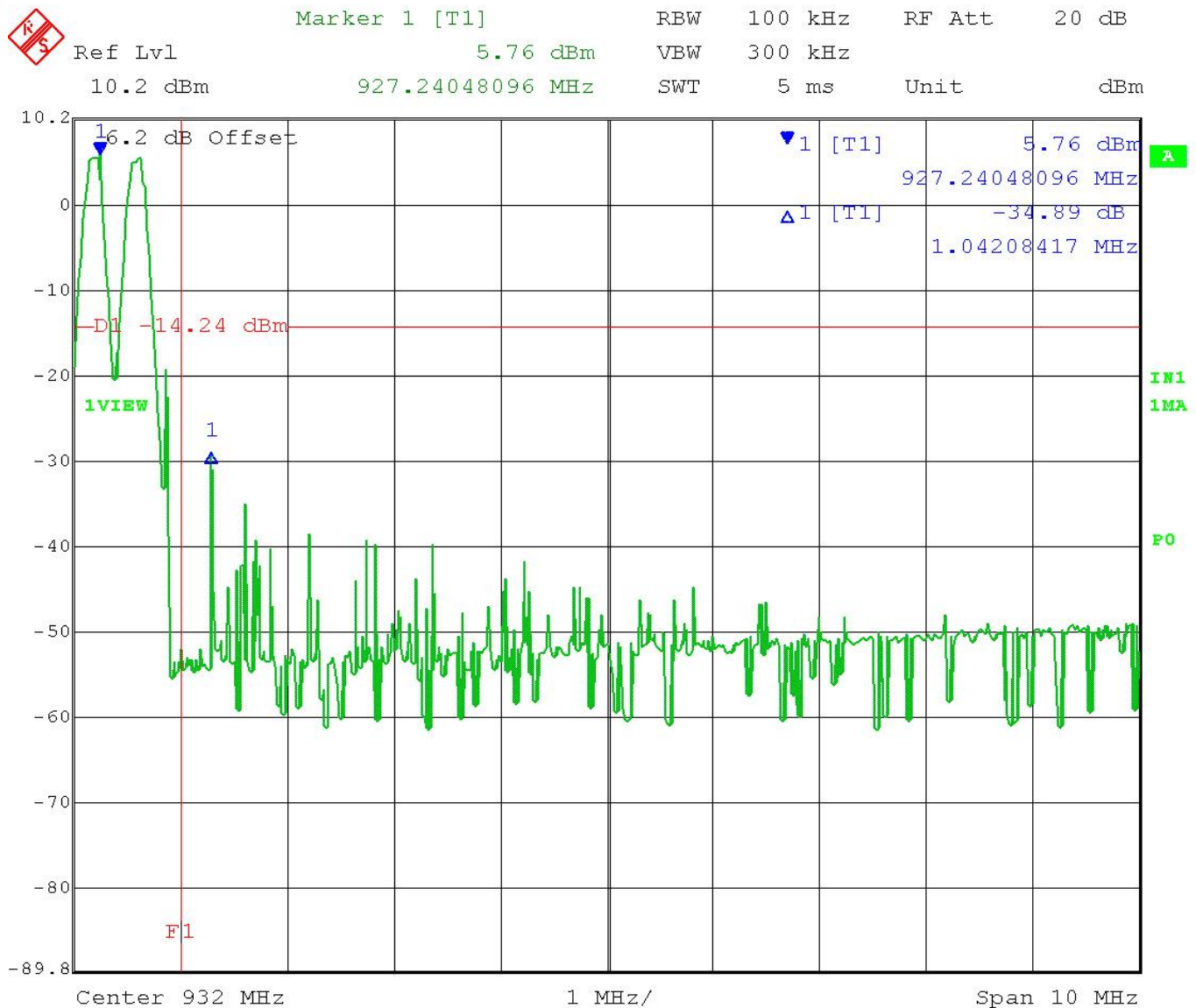
RESULTS: Meets Requirements

Applicant: VERDANT ENVIRONMENTAL TECHNOLOGIES
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BANDEDGE

Test Data: Hopping Upper Band Edge Plot



Date: 18.APR.2016 13:06:51

RESULTS: Meets Requirements

Applicant: VERDANT ENVIRONMENTAL TECHNOLOGIES
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RADIATED SPURIOUS EMISSIONS

Rules Part No.: FCC part 15.247 (d) & 15.209, RSS GEN § 8.9

Requirements: Spurious Emissions found in restricted bands the levels must comply with the general limits found in FCC part 15.209

Frequency	Limits
FCC Part 15.209, IC RSS-GEN 8.9	
9 to 490 kHz	2400/F (kHz) μ V/m @ 300 meters
490 to 1705 kHz	24000/F (kHz) μ V/m @ 30 meters
1705 kHz to 30 MHz	29.54 dB μ V/m @ 30 meters
30 – 88	40.0 dB μ V/m @ 3 meters
80 – 216	43.5 dB μ V/m @ 3 meters
216 – 960	46.0 dB μ V/m @ 3 meters
Above 960	54.0 dB μ V/m @ 3 meters

Test Method: ANSI C63.4 § Annex D Validation of radiated emissions standard test sites
 ANSI C63.10 § 6.3 Common requirements radiated emissions
 ANSI C63.10 § 6.4 Emissions below 30 MHz
 ANSI C63.10 § 6.5 Emissions between 30 & 1000 MHz
 ANSI C63.10 § 6.6 Emissions above 1 GHz
 ANSI C63.10 § 7.5 Procedure for determining the average value of pulsed emissions

Notes: Only emissions found within 20dB of the limit are reported from 9 KHz to 25 GHz for any spurious emission found inside restricted bands of operation as found in FCC Rule Part 15.205, all other spurious emissions not within restricted bands including harmonics were measured during the antenna conducted emissions test.

Where average limits are specified above 1 GHz a duty cycle correction was applied the peak level to determine the average level of the emission

Field Strength Calculation:

The field strength at 3m was established by adding the meter reading of the spectrum analyzer (which is set to read in units of dB μ V) to the antenna correction factor supplied by the antenna manufacturer plus the coax loss. The antenna correction factors are stated in terms of dB. The gain of the preselector was accounted for in the spectrum analyzer meter reading.

Example:

Freq (MHz)	Meter Reading	+ ACF	+ CL = FS
33	20 dB μ V	+ 10.36 dB	+ 0.5 = 30.86 dB μ V/m @ 3m

RADIATED SPURIOUS EMISSIONS

Duty Cycle Formula: $\delta \text{ (dB)} = 20 \log (n_1 t_1 + n_2 t_2 + n_3 t_3) / T$

Where:

δ is the duty cycle correction factor (dB)

T is the pulse width (100 ms period)

t₁ is the pulse width of subpulse 1

t₂ is the pulse width of subpulse 2

t₃ is the pulse width of subpulse 3

n₁ is the number of t₁ pulses

n₂ is the number of t₂ pulses

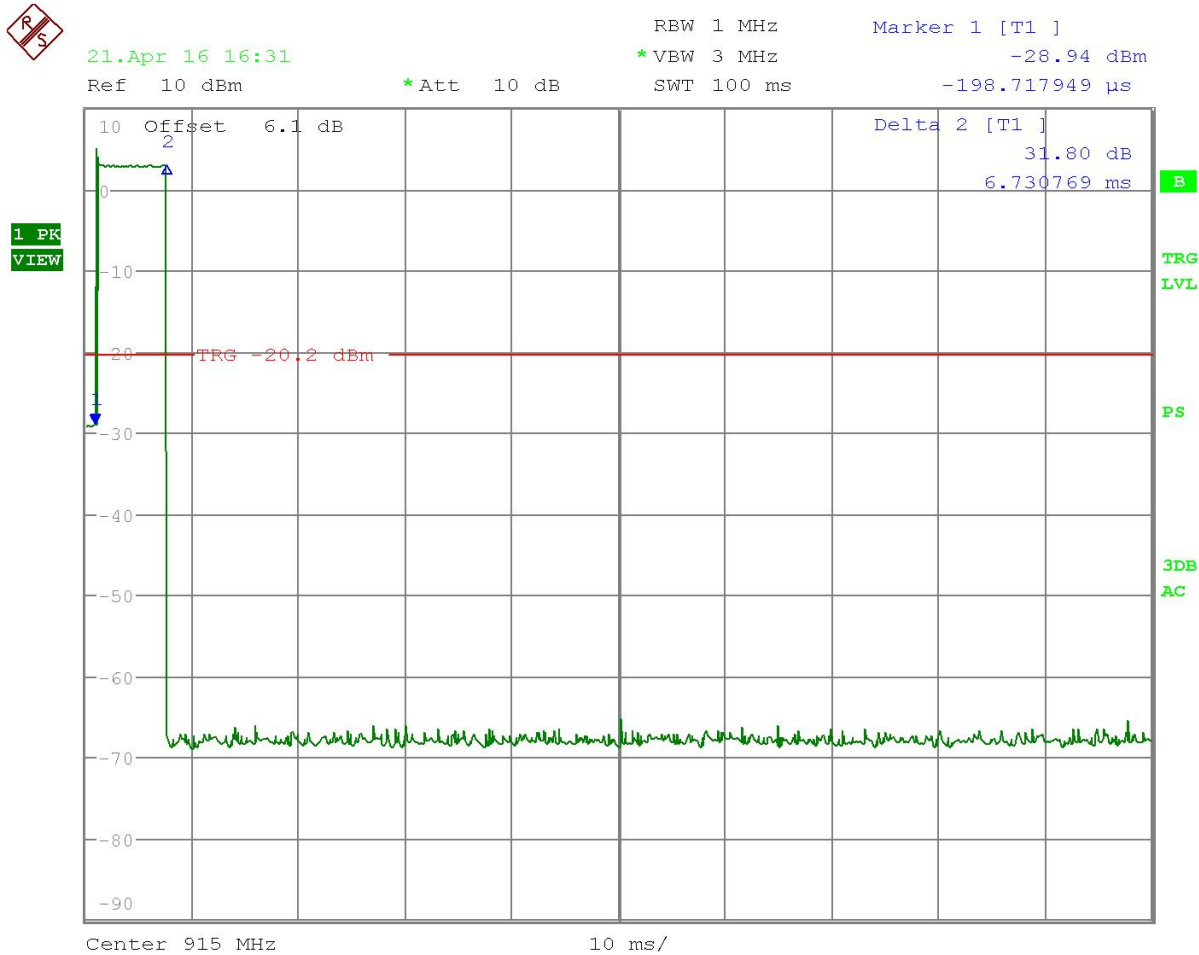
n₃ is the number of t₃ pulses

Test Data: Calculation of Duty Cycle Correction for Average Value of Emissions

Sub Pulse	Duration (ms)	Number (n)	On Time (ms)
1	6.73	1	6.73
Total On Time (ms)			6.73
Period (ms)			100
Duty Cycle (%)			7%
Cor Factor (dB)			-23.44

RADIATED SPURIOUS EMISSIONS

Test Data: Duty Cycle 100 ms Plot



Date: 21.APR.2016 16:31:43

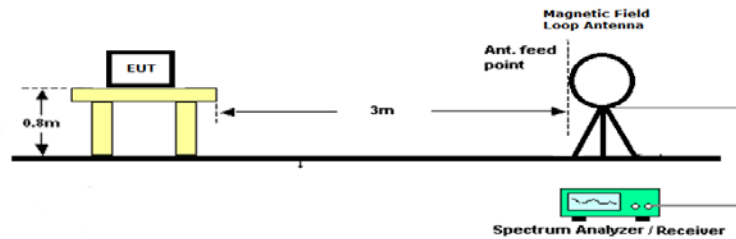
Applicant: VERDANT ENVIRONMENTAL TECHNOLOGIES
FCC ID: XEY90164
IC: 8410A-90164
Report: 370AUT16TestReport

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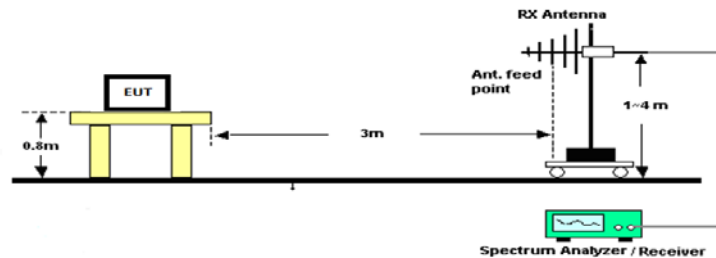
RADIATED SPURIOUS EMISSIONS

Setup:

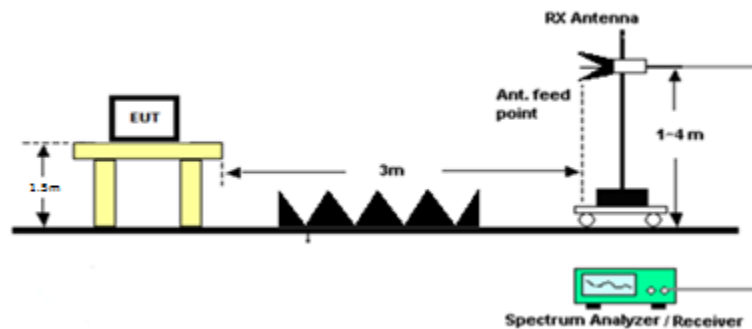
Emissions below 30 MHz



Emissions 30 – 1000 MHz



Emissions above 1 GHz



RADIATED SPURIOUS EMISSIONS

Test Data: Restricted Band Emissions measurement table

Tuned Freq (MHz)	Emission Freq (MHz)	Detector (PK/AV)	Meter Reading (dBuV)	Ant Pol (H/V)	Coax Loss (dB)	Ant Cor Factor (dB)	Duty Cycle (dB)	Field Strength (dBuV/m)	Margin (dB)
902.4	271.99	PK	13.5	H	1.93	14.14	0	29.57	16.43
902.4	282.02	PK	12.8	H	1.97	15.18	0	29.95	16.05
902.4	1,353.55	PK	25.3	H	4.19	29.58	0	59.07	14.93
902.4	1,353.55	AV	25.3	H	4.19	29.58	23.43	35.64	18.36
902.4	2,255.95	PK	18.1	H	5.52	31.5	0	55.12	18.88
902.4	2,255.95	AV	18.1	H	5.52	31.5	23.43	31.69	22.31
902.4	2,707.20	PK	34.8	H	6.04	32.66	0	73.5	0.5
902.4	2,707.20	AV	34.8	H	6.04	32.66	23.43	50.07	3.93
902.4	4,512.00	PK	16.6	H	7.81	33.81	0	58.22	15.78
902.4	4,512.00	AV	16.6	H	7.81	33.81	23.43	34.79	19.21
915	271.99	PK	14.2	H	1.93	14.14	0	30.27	15.73
915	972.19	PK	12.1	H	3.58	24.17	0	39.85	6.15
915	1,372.54	PK	29	H	4.21	29.46	0	62.67	11.33
915	1,372.54	AV	29	H	4.21	29.46	23.43	39.24	14.76
915	2,745.00	PK	33.1	H	6.08	32.48	0	71.66	2.34
915	2,745.00	AV	33.1	H	6.08	32.48	23.43	48.23	5.77
915	3,660.00	PK	20.1	V	7.01	33.62	0	60.73	13.27
915	3,660.00	AV	20.1	V	7.01	33.62	23.43	37.3	16.7
915	4,575.00	PK	18.1	H	7.87	33.88	0	59.85	14.15
915	4,575.00	AV	18.1	H	7.87	33.88	23.43	36.42	17.58
915	7,320.00	PK	15	H	10	35.6	0	60.6	13.4
915	7,320.00	AV	15	H	10	35.6	23.43	37.17	16.83
927.6	1,391.42	PK	26	H	4.23	29.35	0	59.58	14.42
927.6	1,391.42	AV	26	H	4.23	29.35	23.43	36.15	17.85
927.6	2,782.80	PK	32	H	6.11	32.29	0	70.4	3.6
927.6	2,782.80	AV	32	H	6.11	32.29	23.43	46.97	7.03
927.6	3,710.40	PK	19	H	7.06	33.7	0	59.76	14.24
927.6	3,710.40	AV	19	H	7.06	33.7	23.43	36.33	17.67
927.6	4,638.00	PK	16.6	H	7.92	33.94	0	58.46	15.54
927.6	4,638.00	AV	16.6	H	7.92	33.94	23.43	35.03	18.97
927.6	7,420.80	PK	15.6	H	10.07	35.6	0	61.27	12.73
927.6	7,420.80	AV	15.6	H	10.07	35.6	23.43	37.84	16.16

Results Meet Requirements

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EMC EQUIPMENT LIST

Device	Manufacturer	Model	Serial Number	Cal/Char Date	Due Date
Antenna: Biconnical	Eaton	94455-1	1057	11/18/15	11/18/17
Antenna: Log-Periodic	Eaton	96005	1243	02/09/16	02/09/18
Antenna: Passive Loop	EMC Test Systems	EMCO 6512	9706-1211	07/09/15	07/09/17
CHAMBER	Panashield	3M	N/A	02/18/16	08/18/18
Antenna: Double-Ridged Horn/ETS Horn 2	ETS-Lindgren	3117	00041534	02/25/15	02/25/17
EMI Test Receiver R & S ESIB 40	Rohde & Schwarz	ESIB 40	100274	08/12/14	08/12/16
Software: Field Strength Program	Timco	N/A	Version 4.0	NA	NA
EMI Test Receiver R & S ESU 40	Rohde & Schwarz	ESU 40	100320	12/15/14	12/15/17

*EMI RECEIVER SOFTWARE VERSION

The receiver firmware used was version 4.43 Service Pack 3

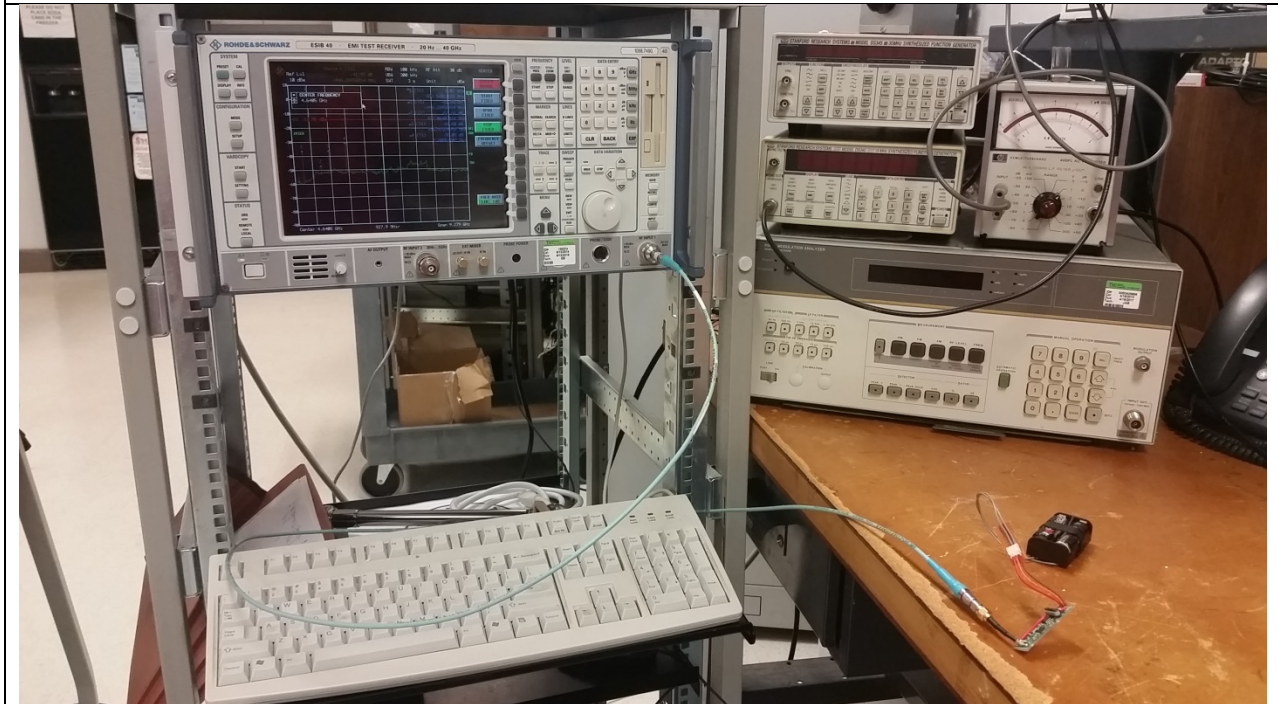
Test Setup Photo

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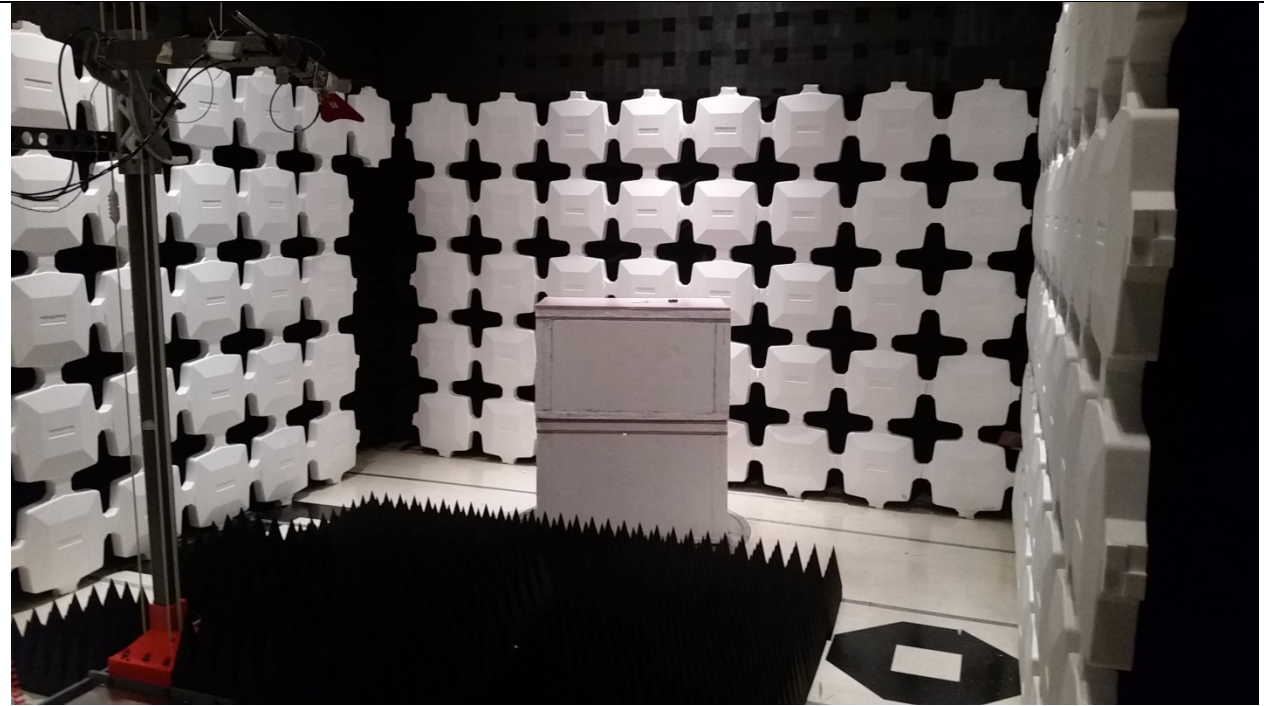
Ant Conducted Measurements



Rad Emissions Below 1 GHz



Rad Emissions Above 1 GHz



Rad Emissions Table Setup

