



Retlif Testing Laboratories

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FCC Part 15, Subpart C, Section 15.247

Test Report

On

FHSS Transceiver Module
FCC ID: R73HPB-24G-1

Customer Name: The Sapling Company, Inc.

Customer P.O.: 0012785

Date of Report: July 18, 2013

Test Report No: R-1861P-1

Test Start Date: May 1, 2013

Test Finish Date: May 3, 2013

Test Technician: D. Fiore

Approved By: Richard J. Reitz

Report Prepared By: C. Reitz

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Technical Information

Report Number: R-1861P-1

Customer: The Sapling Company, Inc.

Address: 1633 Republic Road
Huntingdon, PA 19006

Manufacturer: The Sapling Company, Inc.

Manufacturer Address: 1633 Republic Road
Huntingdon, PA 19006

Test Sample: FHSS Transceiver Module

Model Number: D-CCA-HPB-24G-1

FCC ID: R73HPB-24G-1
Type: 2.433 to 2.449 GHz Frequency Hopping Spread Spectrum Transceiver

Power Requirements: 5 VDC Derived from the Host

Frequency of Operation: 2.433 to 2.449 GHz

Equipment Class: DSS

Equipment Use: Fixed

Test Specification:

FCC Rules and Regulations Part 15, Subpart C, Section 15.247
Radio Standards Specification, RSS-210, Issue 8, June, 2010

Test Procedure:

ANSI C63.4:2003
RSS-GEN, Issue 3, December 2010
Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems,
FCC: DA 00-705



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Tests Performed

The test methods performed on the FHSS Transceiver Module are shown below. All testing was performed with the Transceiver Module installed in the Repeater. Spurious Radiated Emissions testing was also performed with the Transceiver installed in the Master Clock. These two (2) enclosures are representative of all configurations in which the Transceiver Module will be marketed.

Table 1 - Test Methods Performed

FCC Part 15, Subpart C	Test Method
15.247(a)(1)	Channel Separation
15.247(a)(1)	20 dB Bandwidth
15.247(a)(1)(iii)	Number of Channels and Occupancy Time
15.247(b)(1) and (4)	Peak Conducted Output Power
15.247(d)	Spurious Emissions, 30 MHz to 25 GHz
15.247(d)/15.209(a)	Field Strength of Spurious Emissions
15.207(a)	Conducted Emissions, Power Leads, 150 kHz to 30 MHz



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Certification and Signatures

We certify that this report is a true representation of the results obtained from the tests of the equipment stated. We further certify that the measurements shown in this report were made in accordance with the procedures indicated and vouch for the qualifications of all Retlif Testing Laboratories personnel taking them.



Dean Landers
EMC Test Engineer



Richard J. Reitz
Corporate Laboratory Manager
iNARTE Certified Engineer ATL-0036-E
NVLAP Approved Signatory

Non-Warranty Provision

The testing services have been performed, findings obtained and reports prepared in accordance with generally accepted laboratory principles and practices. This warranty is in lieu of all others, either expressed or implied.

Non-Endorsement

This test report contains only findings and results arrived at after employing the specific test procedures and standards listed herein. It is not intended to constitute a recommendation, endorsement or certification of the product or material tested. This test report must not be used by the client to claim product endorsement by NVLAP or any agency of the U.S. Government.



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Requirements and Test Results

Requirement:

FCC Section 15.247 (a)(1)

Channel Separation and 20 dB Bandwidth

Frequency hopping systems 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. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. 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.

- Results:
The carrier frequencies were separated by 200 kHz which complied with the requirements specified above.

FCC Section 15.247 (a)(1)(iii)

Number of Channels and Occupancy Time

Frequency hopping systems operating in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

- The test sample utilized 75 channels. The average Time of Occupancy was not greater than 0.4 seconds with a period of 30 seconds.



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Requirements and Test Results (con't)

FCC Section 15.247 (b)(1) and (4) Peak Conducted Output Power

(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

(4) The conducted output power limit specified in Paragraph (b) of Section 15.247 is based on the use of antenna with directional gains that do not exceed 6 dBi. Except as shown in Paragraph (c) of Section 15.247, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in Paragraph (b)(1), (b)(2) and (b)(3) of Section 15.247, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

- **Results**

The frequency hopping system utilized a transmitting antenna with a directional gain of 2.15 dBi therefore, the peak output power limit was 1 watt. The maximum peak conducted output power was measured to be 891.0 milliwatts.

FCC Section 15.247(d) Spurious Emissions

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 that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under Paragraph (b)(3) of Section 15.247, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a) must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

- **Results**

The antenna conducted spurious emissions comply with the requirement that the radio frequency power be at least 20 dB below the highest in band level.

In addition, Harmonic and Spurious Emissions which were found to be within the restricted bands of operation, as defined in section 15.205(a) were found to be in compliance with the general limits specified in section 15.209(a).



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Requirements and Test Results (con't)

FCC Section 15.247(d)

Field Strength of Spurious Radiation (Restricted Bands)

Radiated Emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a).

- Results:
The field strength of spurious radiated emissions located in the restricted bands did not exceed the limits specified.

Requirement:

FCC Section 15.207(a) - Conducted Limits

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits shown in Table 2, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of the paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Table 2 - Conducted Emission Limits

Frequency of Emission (MHz)	Conducted Limit (dB μ V)	
	Quasi-Peak	Average
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50
*Decreases due to logarithm of the frequency		

- Results:
The conducted emissions observed did not exceed the limits specified in Table 2.



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Requirements and Test Results (con't)

FCC Section 15.247(i)

RF Exposure Limits

Spread Spectrum Transmitters operating under 15.247 are categorically excluded from routine environmental evaluation for demonstrating RF exposure compliance with respect to MPE or SAR limits however per 15.247(i) must be operated in a manner that ensures the public is not exposed to RF energy levels in excess of the commission's guidelines. The user/installation manual contains the proper cautionary statements and specifies that the device be installed and operated so that a minimum separation distance of 11 cm will be maintained. Based on the transmitter power and maximum antenna gain (see calculation below) the 11 cm separation distance exceeds the calculated distance for acceptable MPE power density levels to meet both the Occupational/Controlled Exposure and the General Population/Uncontrolled Exposure requirements of FCC Part 1.1310. The calculation below uses the more stringent General Population MPE Limits.

$$S = \frac{PG}{4\pi Dsq}$$

D = Minimum Separation Distance in cm

S = Max allowed Power Density in mW/cmsq

Per 1.1310 For the Frequency of 2.4 GHz = 1.0 mW/cm²

Power = Max Power Input to Antenna = 891 mW

Gain = Max Power Gain of Antenna = 2.15 dBi = 1.64

$$1.0 \text{ mW/cm}^2 = \frac{891 \times 1.64}{4 \times (3.14) \times D^2}$$

$$D^2 = \frac{1461.2}{12.56 \times 1.0}$$

$$D = \sqrt{116} = 10.78 \text{ cm}$$



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Equipment Lists

FCC Section 15.247(a)(1) Channel Separation

EN	Manufacturer	Description	Range	Model No.	Cal Date	Due Date
8100	NARDA	20DB ATTENUATOR	10 kHz-11 GHz	768-20	6/4/2012	6/30/2013
R603	AGILENT / HP	SPECTRUM ANALYZER	100 kHz - 26.5 GHz	E7405A;B	6/18/2012	6/18/2013

FCC Section 15.247(a)(1) 20 dB Bandwidth

EN	Manufacturer	Description	Range	Model No.	Cal Date	Due Date
8100	NARDA	20DB ATTENUATOR	10 kHz-11 GHz	768-20	6/4/2012	6/30/2013
R603	AGILENT / HP	SPECTRUM ANALYZER	100 kHz - 26.5 GHz	E7405A;B	6/18/2012	6/18/2013

FCC Section 15.247(a)(1)(iii) Number of Channels and Occupancy Time

EN	Manufacturer	Description	Range	Model No.	Cal Date	Due Date
8100	NARDA	20DB ATTENUATOR	10 kHz-11 GHz	768-20	6/4/2012	6/30/2013
R603	AGILENT / HP	SPECTRUM ANALYZER	100 kHz - 26.5 GHz	E7405A;B	6/18/2012	6/18/2013

FCC Section 15.247(a)(1) Peak Conducted Output Power

EN	Manufacturer	Description	Range	Model No.	Cal Date	Due Date
8100	NARDA	20DB ATTENUATOR	10 kHz-11 GHz	768-20	6/4/2012	6/30/2013
8329	STACO	AC POWER SOURCE	0 - 140 VAC 9 Amp	E1010VAW	Calibrate Before Use	
R603	AGILENT / HP	SPECTRUM ANALYZER	100 kHz - 26.5 GHz	E7405A;B	6/18/2012	6/18/2013

FCC Section 15.247(d) Spurious Emissions, 30 MHz to 25 GHz

EN	Manufacturer	Description	Range	Model No.	Cal Date	Due Date
713	ROHDE & SCHWARZ	EMI TEST RECEIVER	20 Hz - 26.5 GHz	ESIB26	6/8/2012	6/30/2013
8100	NARDA	20DB ATTENUATOR	10 kHz-11 GHz	768-20	6/4/2012	6/30/2013
8103	WEINSCHEL	3DB ATTENUATOR	DC-18 GHz	23-3-33	6/4/2012	6/30/2013
8321	NARDA	6.0DB ATTENUATOR	DC - 18 GHz	779-6DB	1/15/2013	1/31/2014
8457	GENERAL TECHNICS	Control Computer				



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Equipment Lists (con't)

FCC Section 15.247(d) / 15.209(a) Field Strength of Spurious Emissions

EN	Manufacturer	Description	Range	Model No.	Cal Date	Due Date
713D	MICRO-COAX 50U50U	CABLE ASSEMBLY	3 FT.	UFB311A1-0360-	8/13/2012	8/31/2013
713E	MICRO-COAX 50U50U	CABLE ASSEMBLY	6 FEET	UFB311A1-0720-	8/13/2012	8/31/2013
713F	MICRO-COAX 50U50U	CABLE ASSEMBLY	25 FT	UFB311A1-2400-	8/13/2012	8/31/2013
8018	EMCO ANTENNA	DOUBLE RIDGED GUIDE	1 GHZ - 18 GHZ	3115	5/24/2012	5/31/2013
8071	AGILENT / HP	SPECTRUM ANALYZER	100Hz-2.5 GHz/2-22GH	8566B	6/7/2012	6/30/2013
8072	AGILENT / HP DISPLAY	SPECTRUM ANALYZER		85662A	6/7/2012	6/30/2013
8317	AGILENT / HP	PRE-AMPLIFIER	1-26.5 GHz, 30 dB	8449B	6/7/2012	6/30/2013

FCC Section 15.207(a) Conducted Emissions, Power Leads

EN	Manufacturer	Description	Range	Model No.	Cal Date	Due Date
713	ROHDE & SCHWARZ	EMI TEST RECEIVER	20 Hz - 26.5 GHz	ESIB26	6/8/2012	6/30/2013
8074	GENERAL ELECTRIC	AC POWER SOURCE	120V / 120V	9T51B33G3	Calibrate Before Use	
8194	SOLAR ELECTRONICS	LINE IMPEDANCE STABILIZATION NETWORK	10 kHz - 30 MHz	8028-50-TS-24-B	1/14/2013	1/31/2014
8195	SOLAR ELECTRONICS	LINE IMPEDANCE STABILIZATION NETWORK	10 kHz - 30 MHz	8028-50-TS-24-B	1/14/2013	1/31/2014
8276	ELGAR	TRANSFORMER	2.5-13		No Calibration Required	
8357	NARDA	10.0DB ATTENUATOR	DC - 11 GHz, 20 W	768-10	6/5/2012	6/30/2013
8457	GENERAL TECHNICS	Control Computer				



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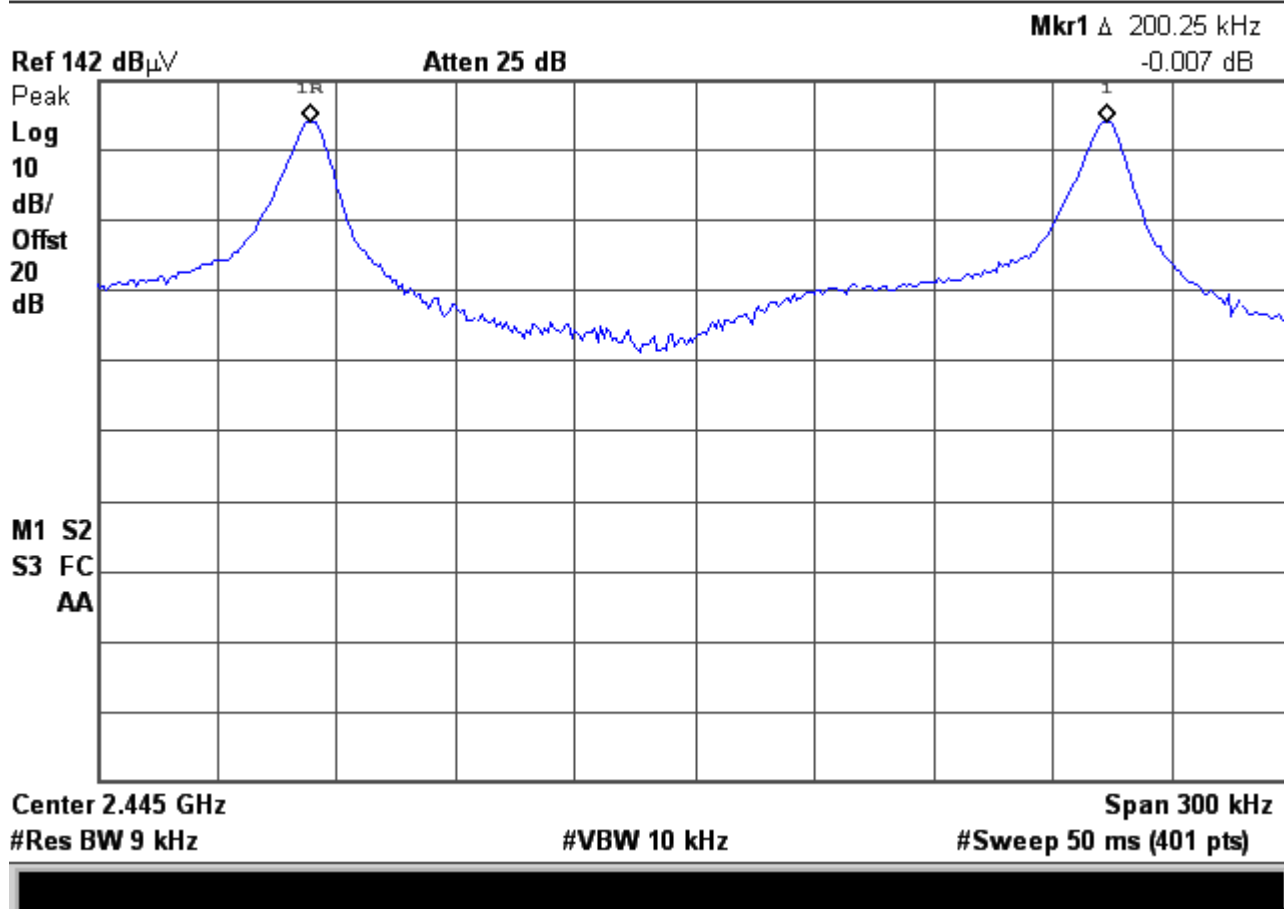
**FCC Section 15.247(a)(1)
Channel Separation**

Test Data



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**FCC Section 15.247(a)(1)
20 dB Bandwidth**

Test Data



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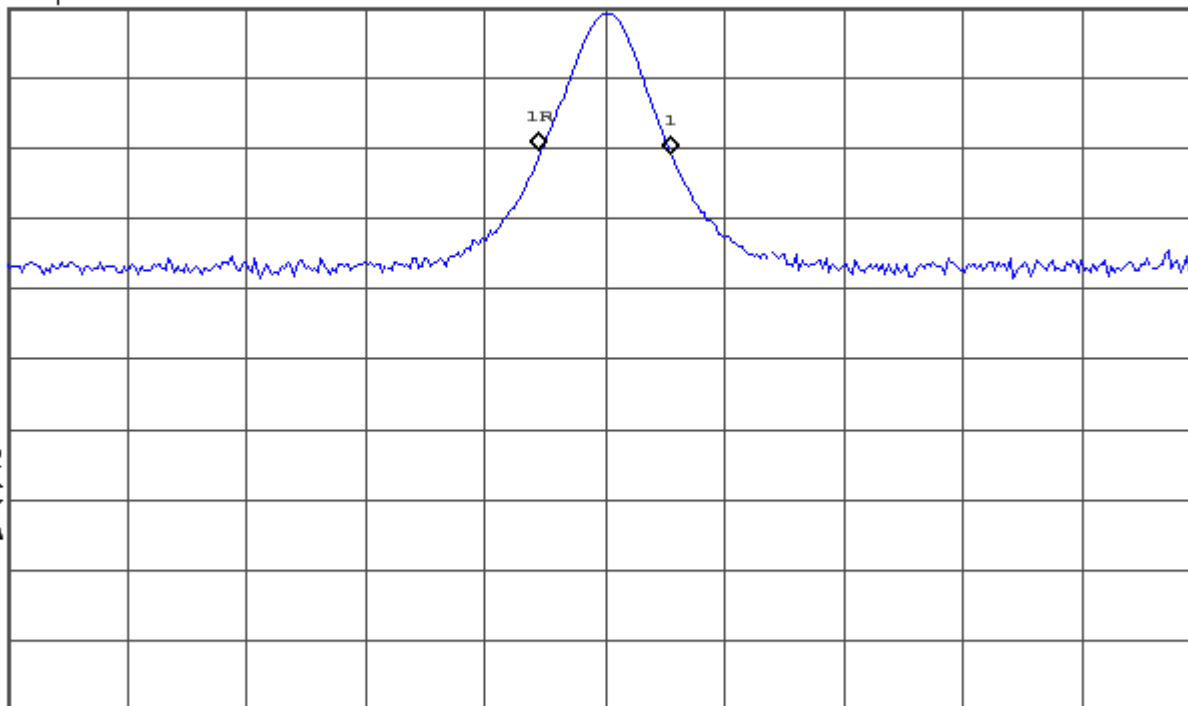
Mkr1 Δ 10.75 kHz
-0.533 dB

Ref 137 dB μ V

#Atten 20 dB

Peak
Log
10
dB/
Offst
20
dB

M1 S2
S3 FC
AA



Center 2.441 GHz

Span 100 kHz

#Res BW 3 kHz

#VBW 10 kHz

#Sweep 500 ms (401 pts)



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FCC Section 15.247(a)(1)(iii)
Number of Channels and Occupancy Time

Test Data



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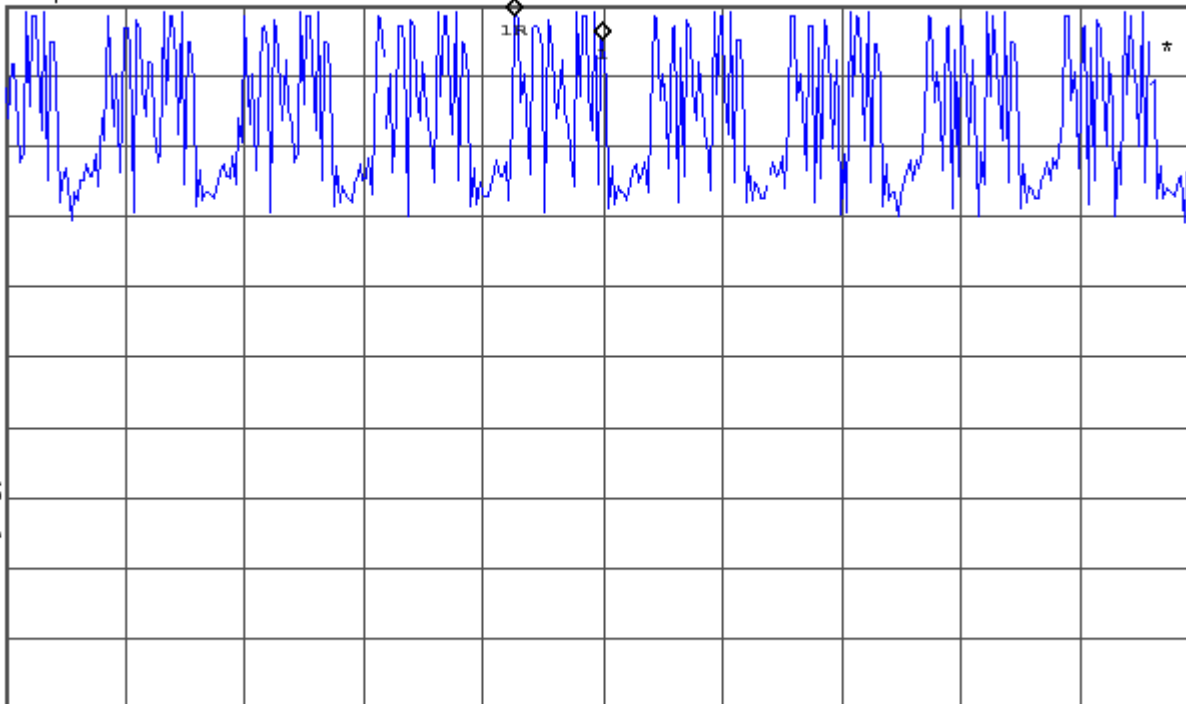
Report No. R-1861P-1

Mkr1 Δ 103.6 ms
-3.671 dB

Ref 137 dB μ V

#Atten 20 dB

Peak
Log
10
dB/
Offset
20
dB



Center 2.44 GHz

Res BW 1 MHz

#VBW 3 MHz

Span 0 Hz
Sweep 1.429 s (401 pts)



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**FCC Section 15.247 (b)(1)(4)
Peak Conducted Output Power**

Test Data



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Test Method:		FCC Part 15, Subpart C, Section 15.247 (b), Power Output			
Customer:		Sapling, Inc.		Job No.	R-1861P-1
Test Sample:		FHSS Transceiver Module			
Model No.:		D-CCA-HPB-24G-1		FCC ID:	R73HPB-24G-1
Operating Mode:		Continuous CW Transmission at Discrete Hopping Frequencies			
Technician:		D.Fiore		Date:	05/3/13
Notes:	Reference Level:	35dBm	Resolution BW:	5MHz	
	Video Bandwidth:	3MHz	SweepTime:	5ms	
	RF Attenuation:	30dB	Span:	200kHz	
	External Attenuation:	20dB			

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FCC Section 15.247 (d)
Spurious Conducted Emissions, 30 MHz to 25 GHz

Test Data

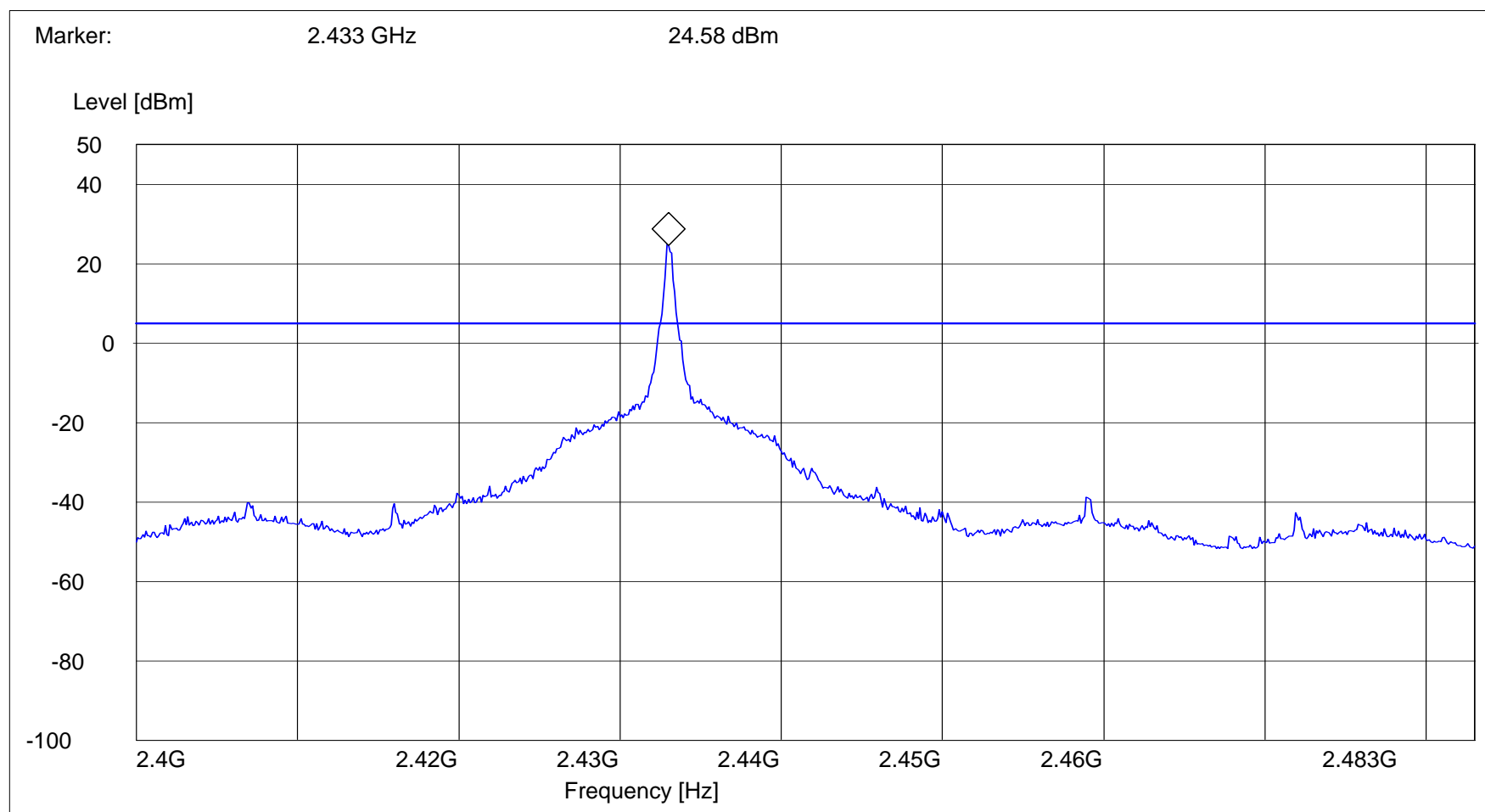


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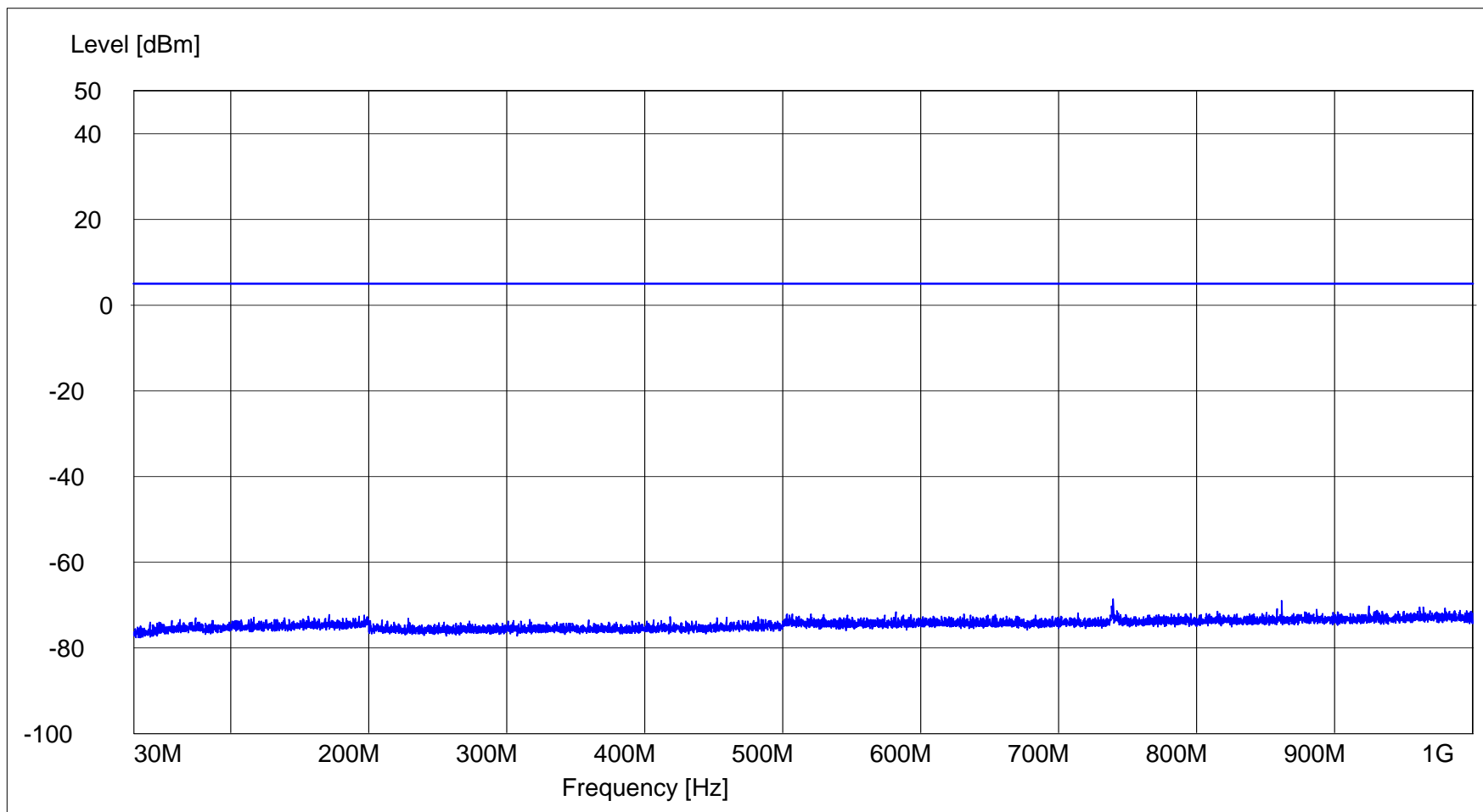
FCC 15.247 (d) Spurious RF Conducted Emissions

Customer: Sapling, Inc.
Test Sample: Transceiver (Repeater)
Model Number: D-CCA-HPB-24G-1
Test Specification: FCC 15.247 (d)
Mode of Operation: Continuous Modulated Transmission at Discrete Hopping Frequencies
Technician/Date: D.Fiore 05/01/13
Notes: Channel 0



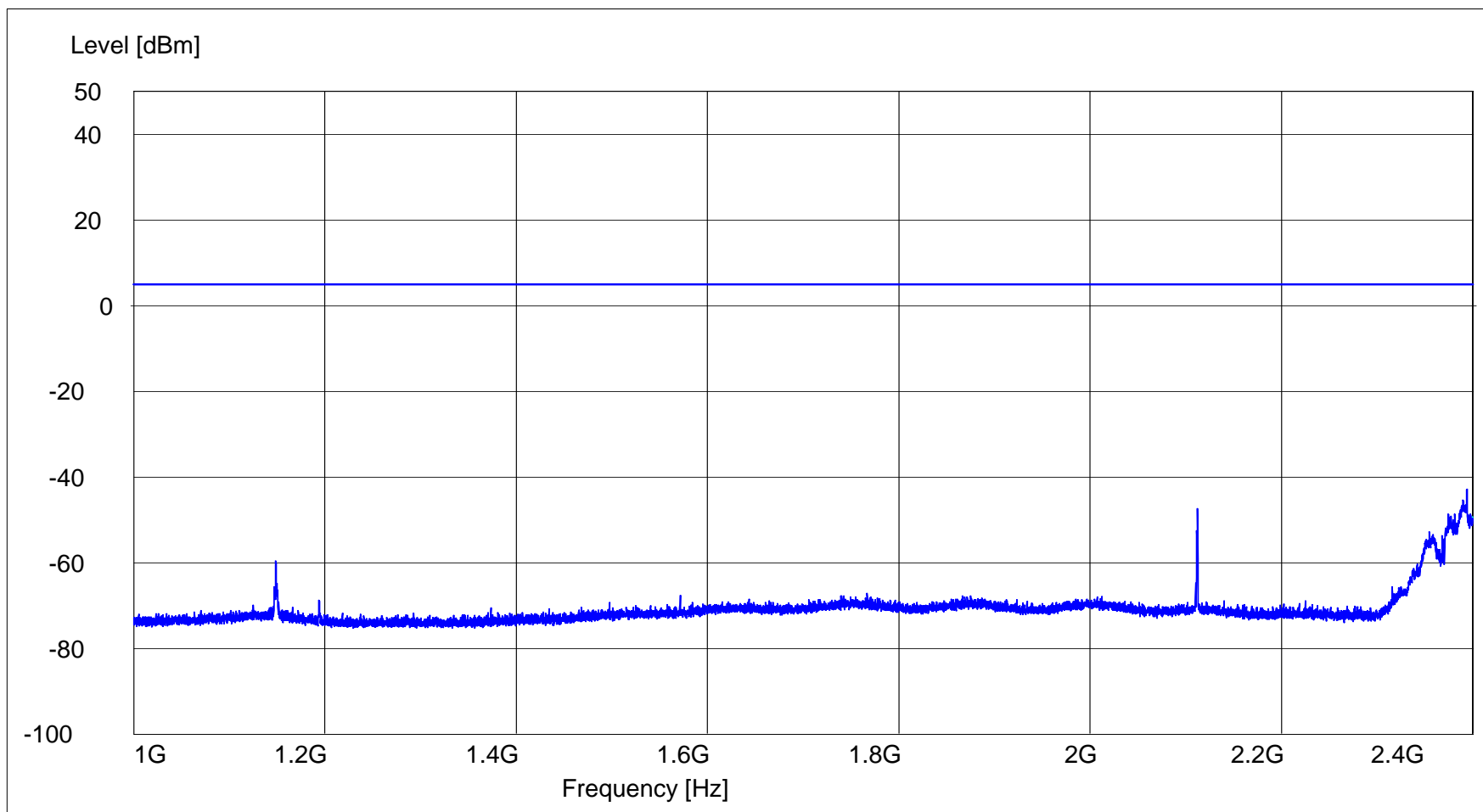
FCC 15.247 (d) Spurious RF Conducted Emissions

Customer: Sapling, Inc.
Test Sample: Transceiver (Repeater)
Model Number: D-CCA-HPB-24G-1
Test Specification: FCC 15.247 (d)
Mode of Operation: Continuous Modulated Transmission at Discrete Hopping Frequencies
Technician/Date: D.Fiore 05/01/13
Notes:



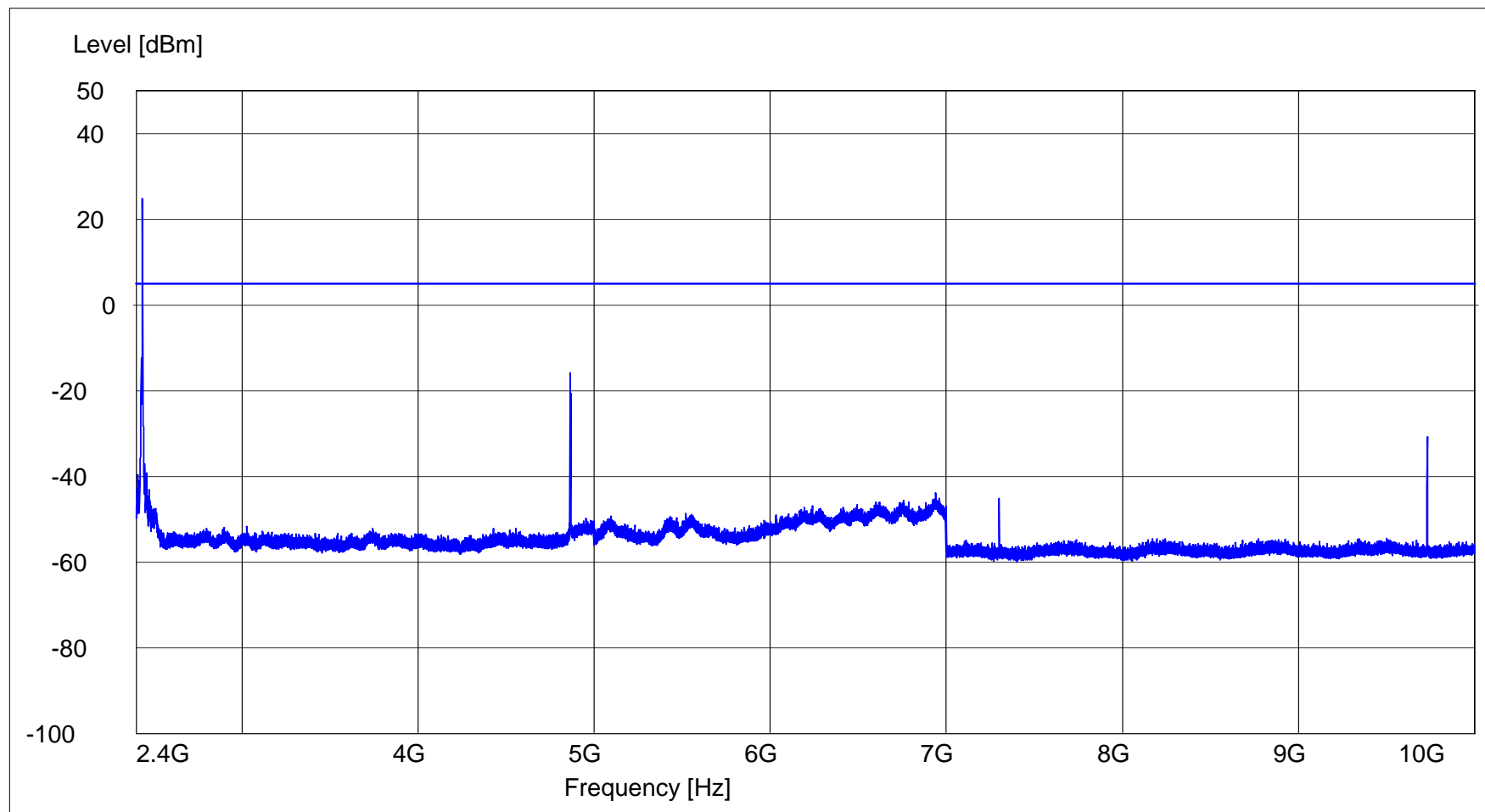
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Test Specification: FCC 15.247 (d)
Mode of Operation: Continuous Modulated Transmission at Discrete Hopping Frequencies
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Notes:



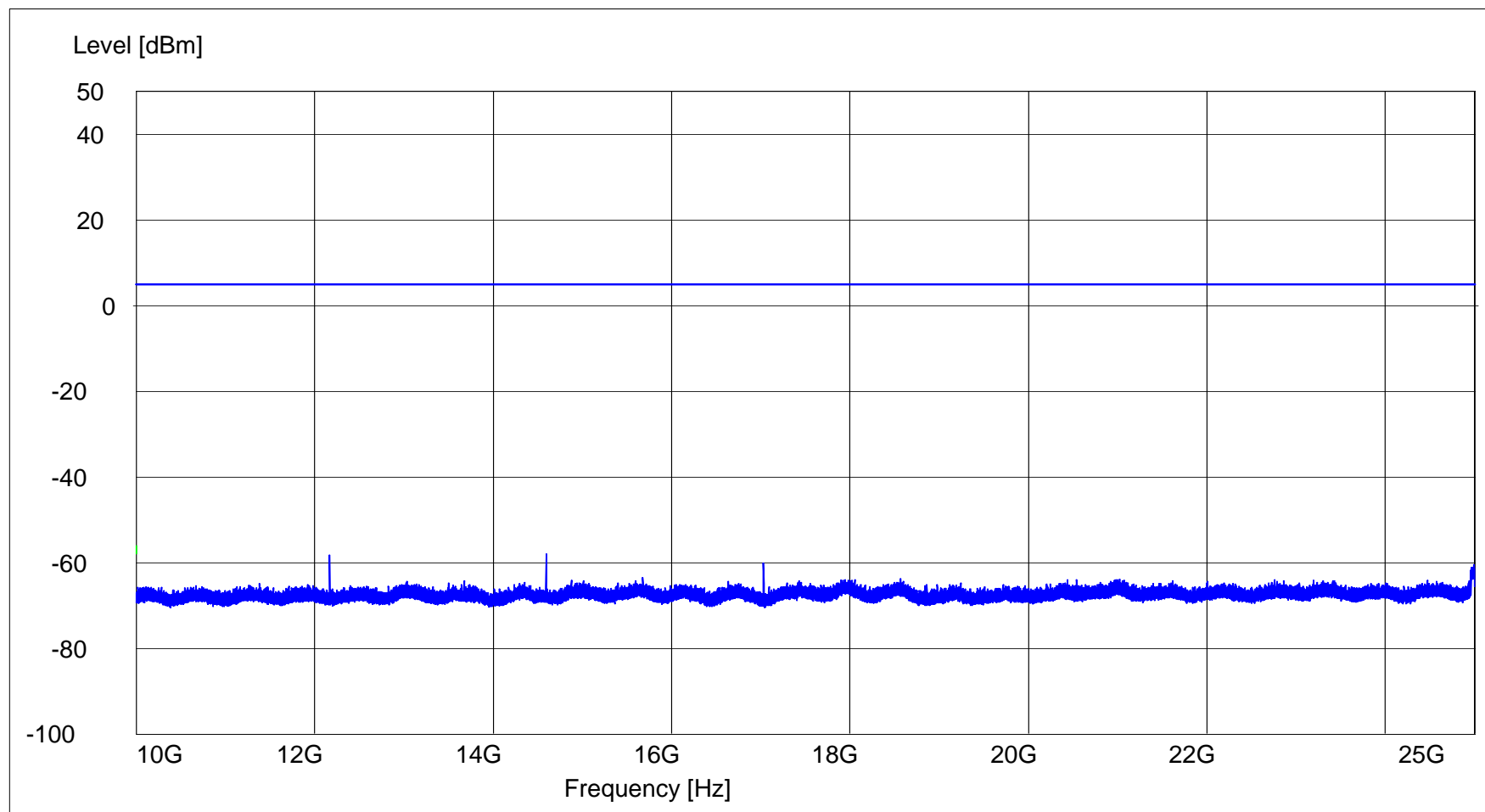
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Notes:



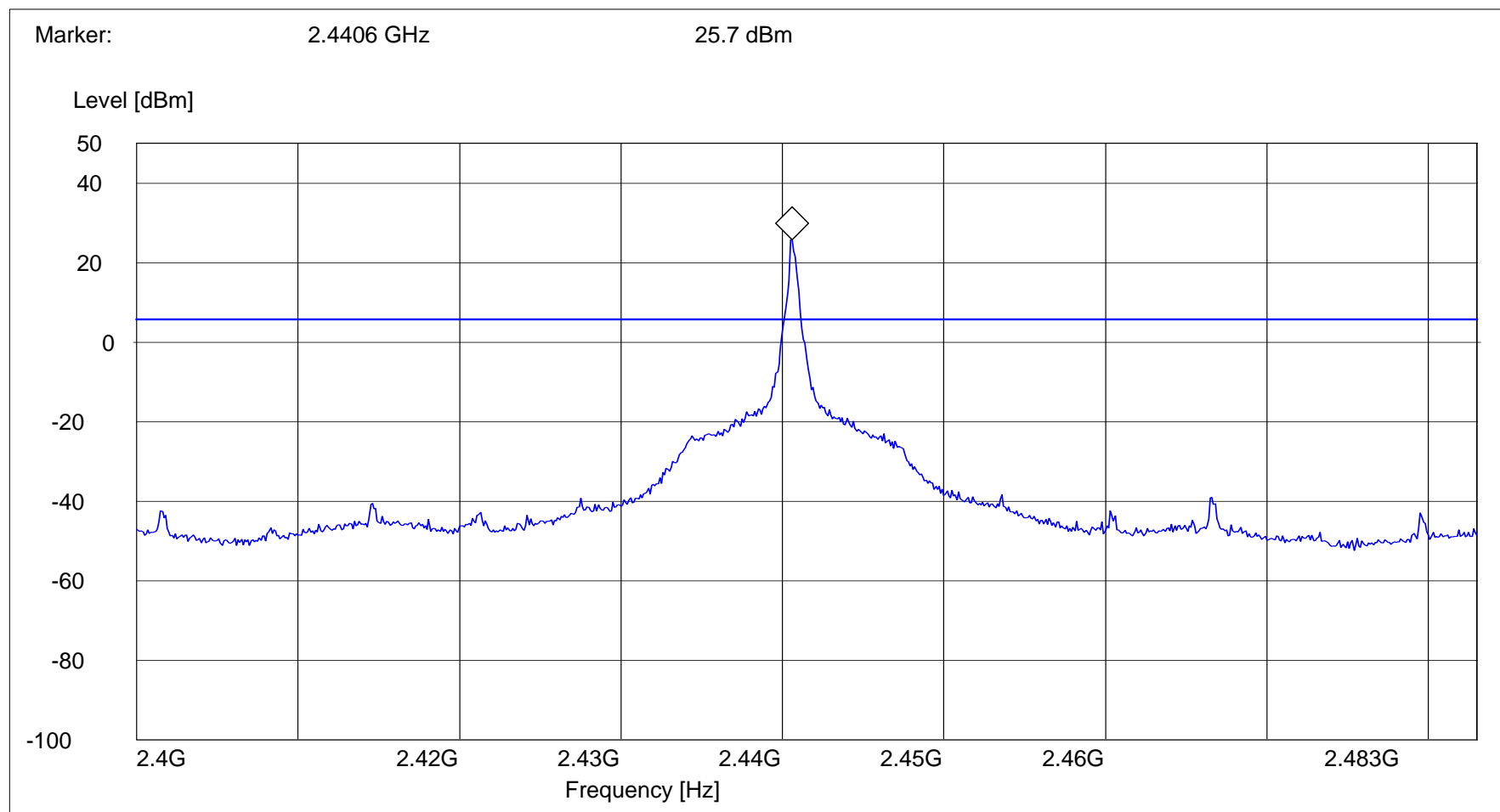
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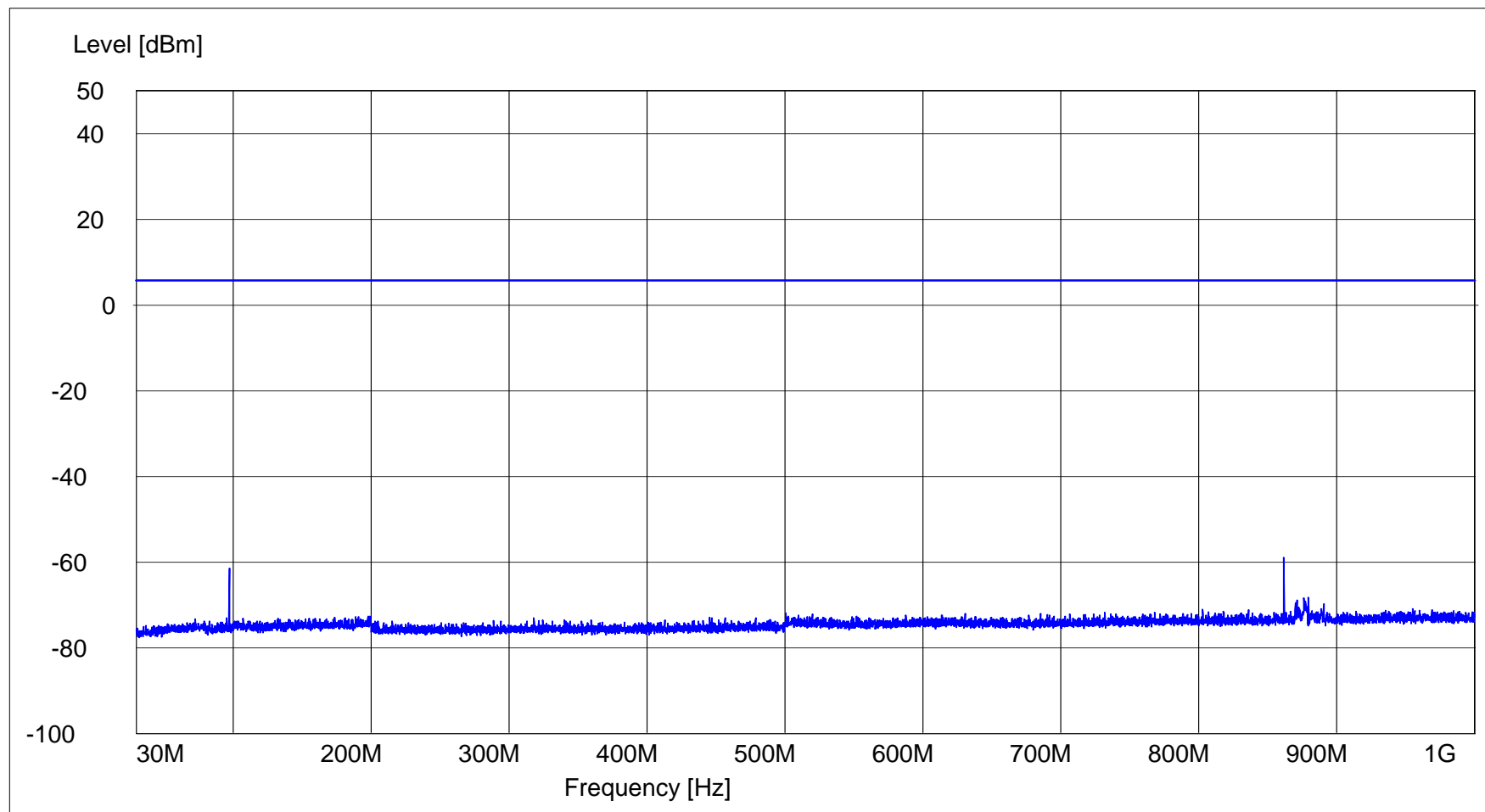
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Technician/Date: D.Fiore 05/01/13
Notes: Channel 1



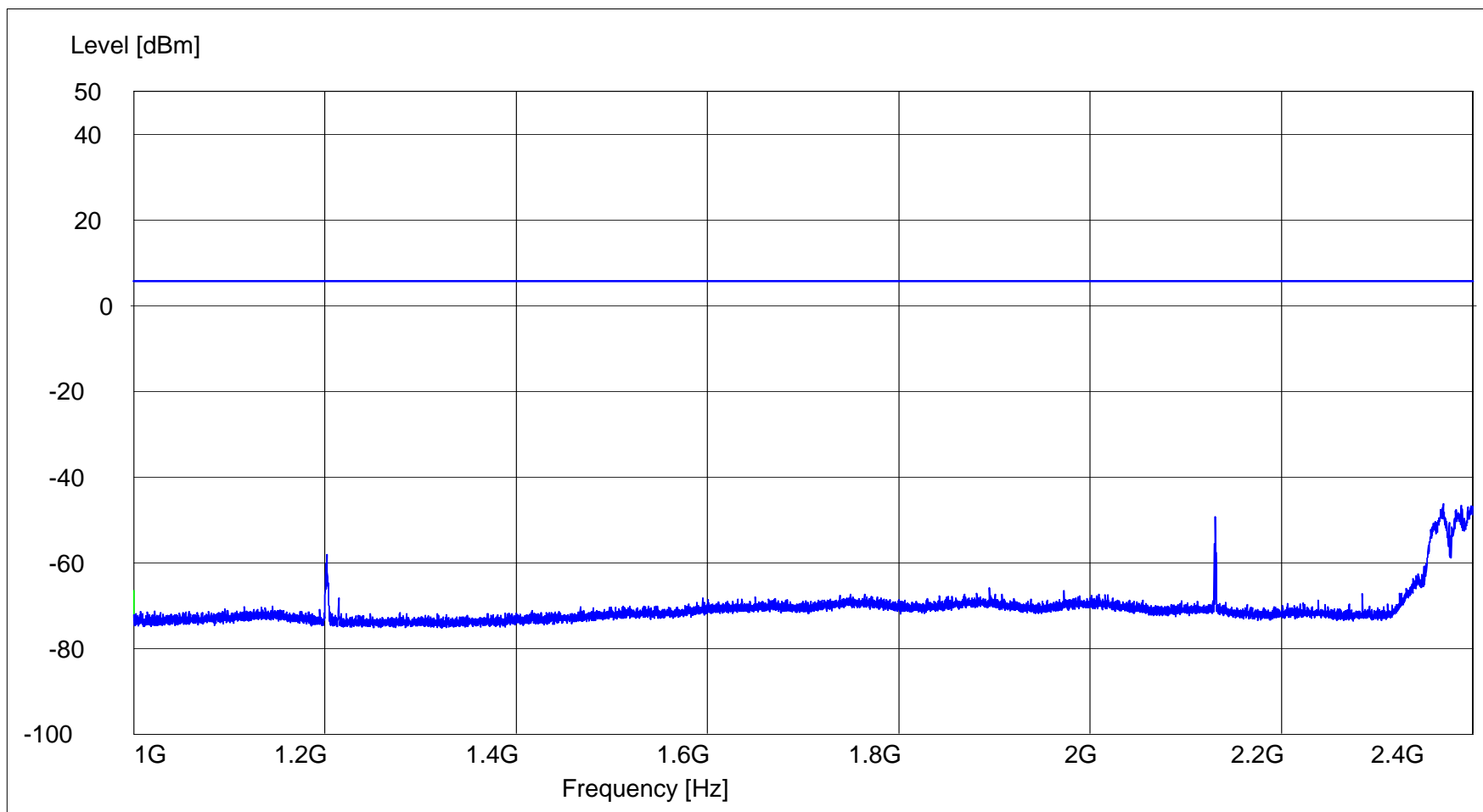
FCC 15.247 (d) Spurious RF Conducted Emissions

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Test Specification: FCC 15.247 (d)
Mode of Operation: Continuous Modulated Transmission at Discrete Hopping Frequencies
Technician/Date: D.Fiore 05/01/13
Notes: Transmitting on Ch 1



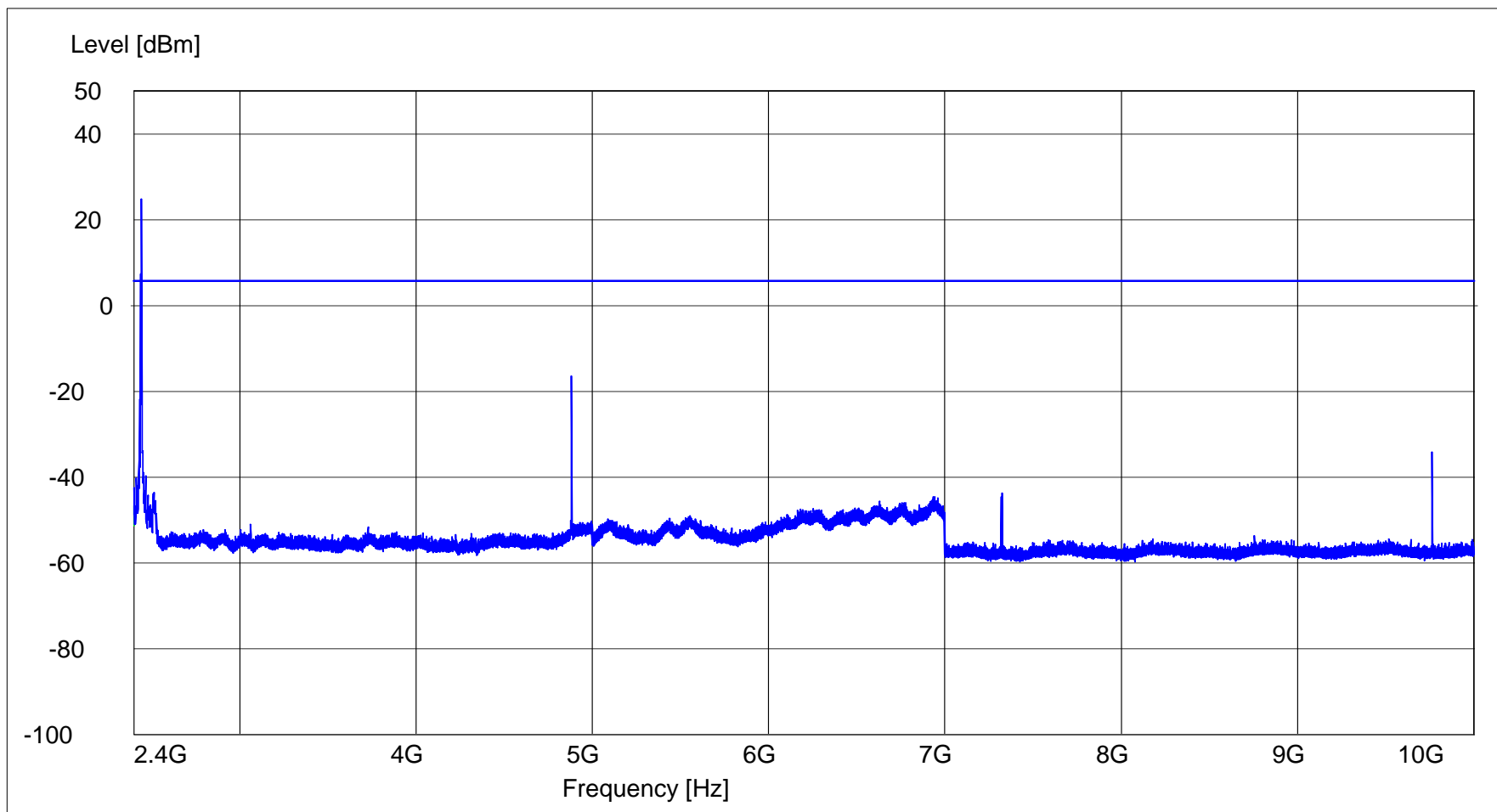
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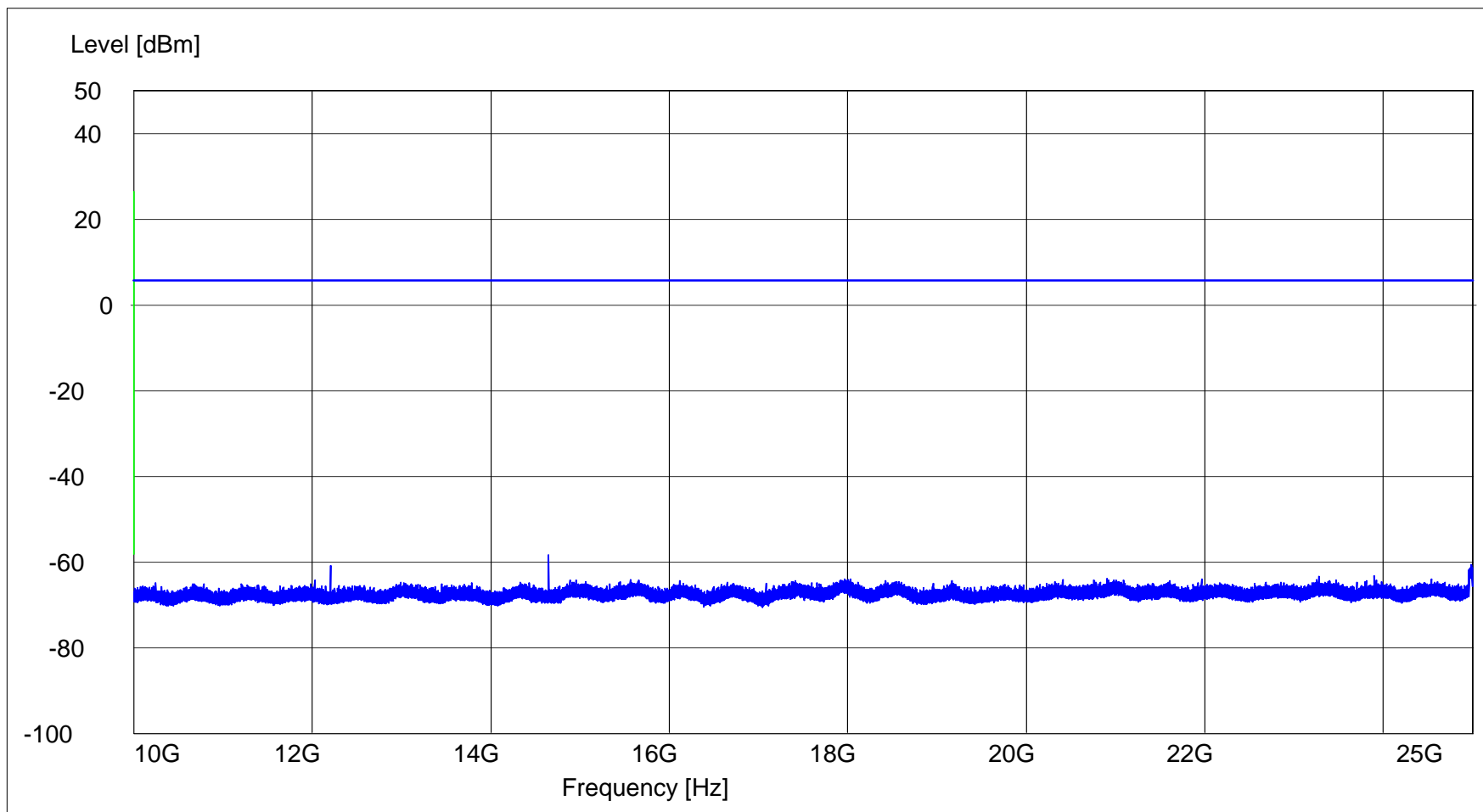
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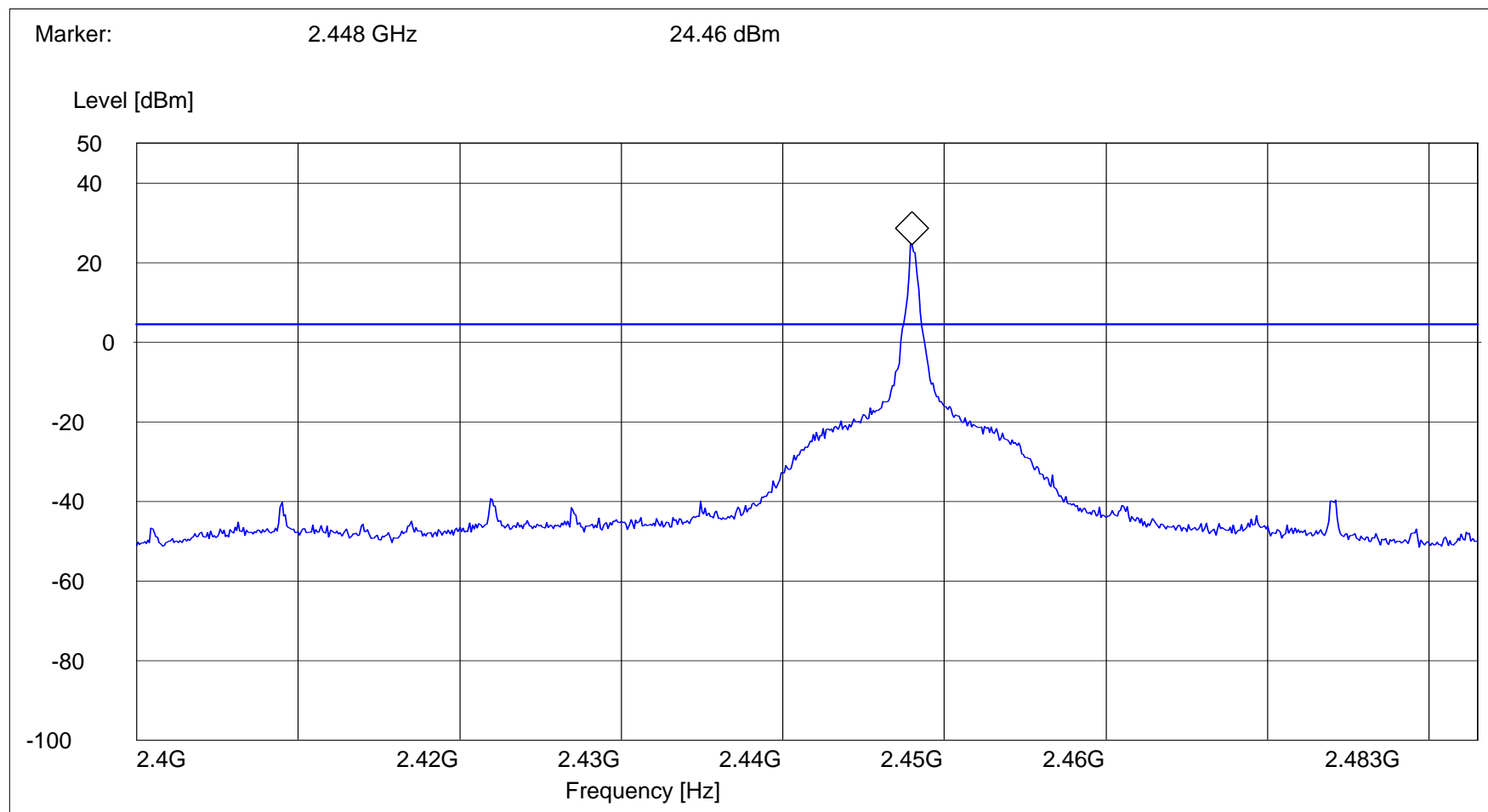
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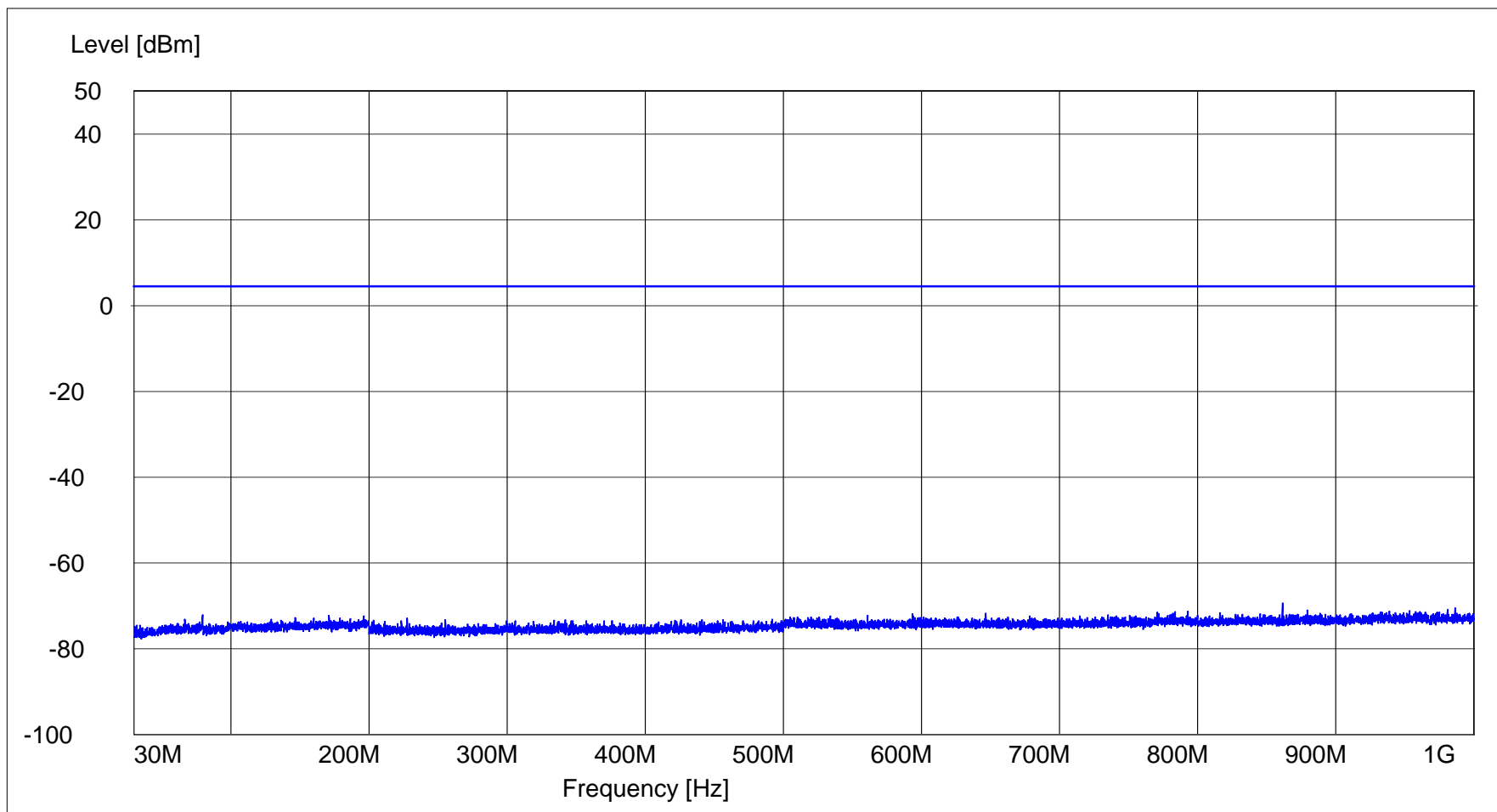
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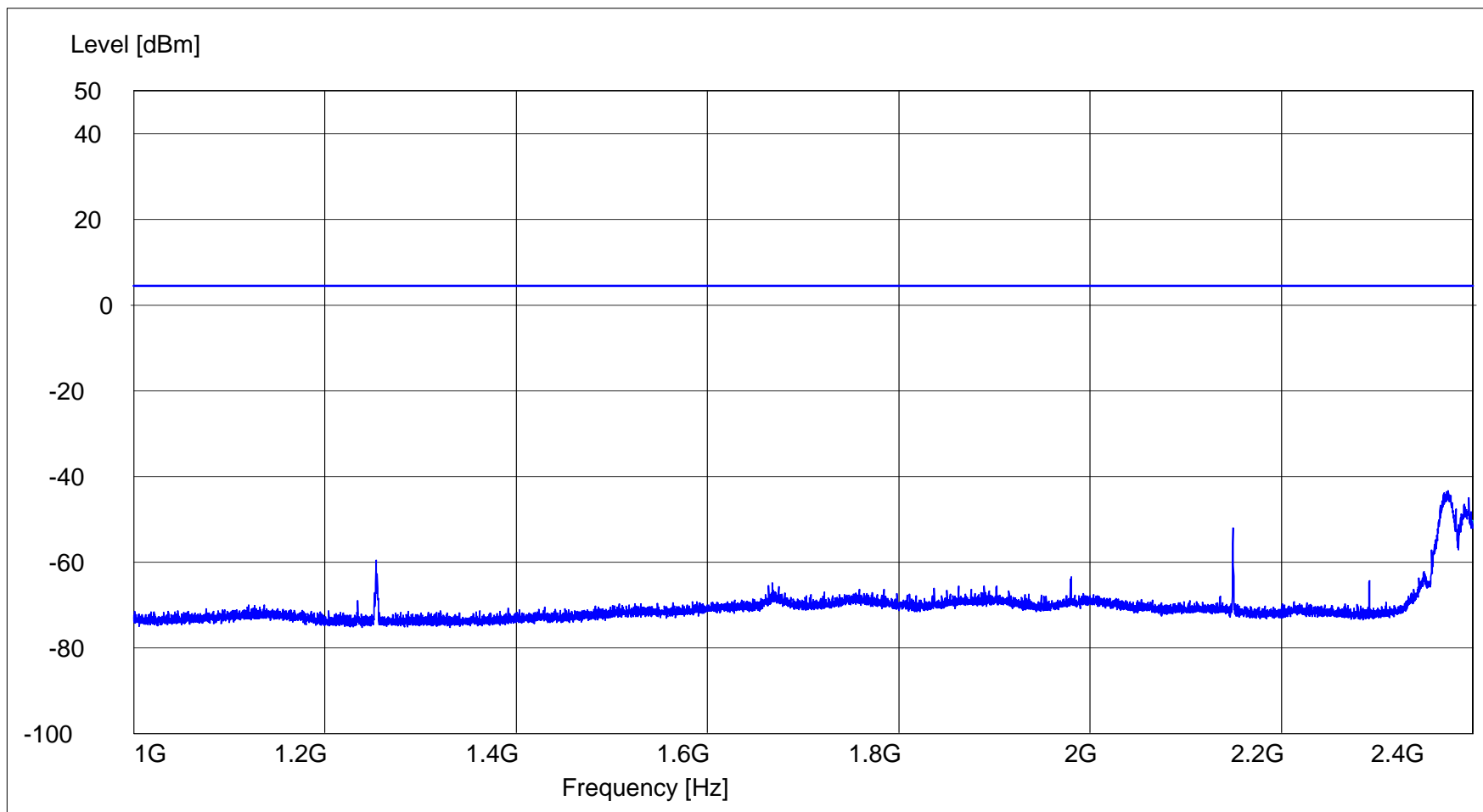
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Test Specification: FCC 15.247 (d)
Mode of Operation: Continuous Modulated Transmission at Discrete Hopping Frequencies
Technician/Date: D.Fiore 05/01/13
Notes: Transmitting on Ch 2



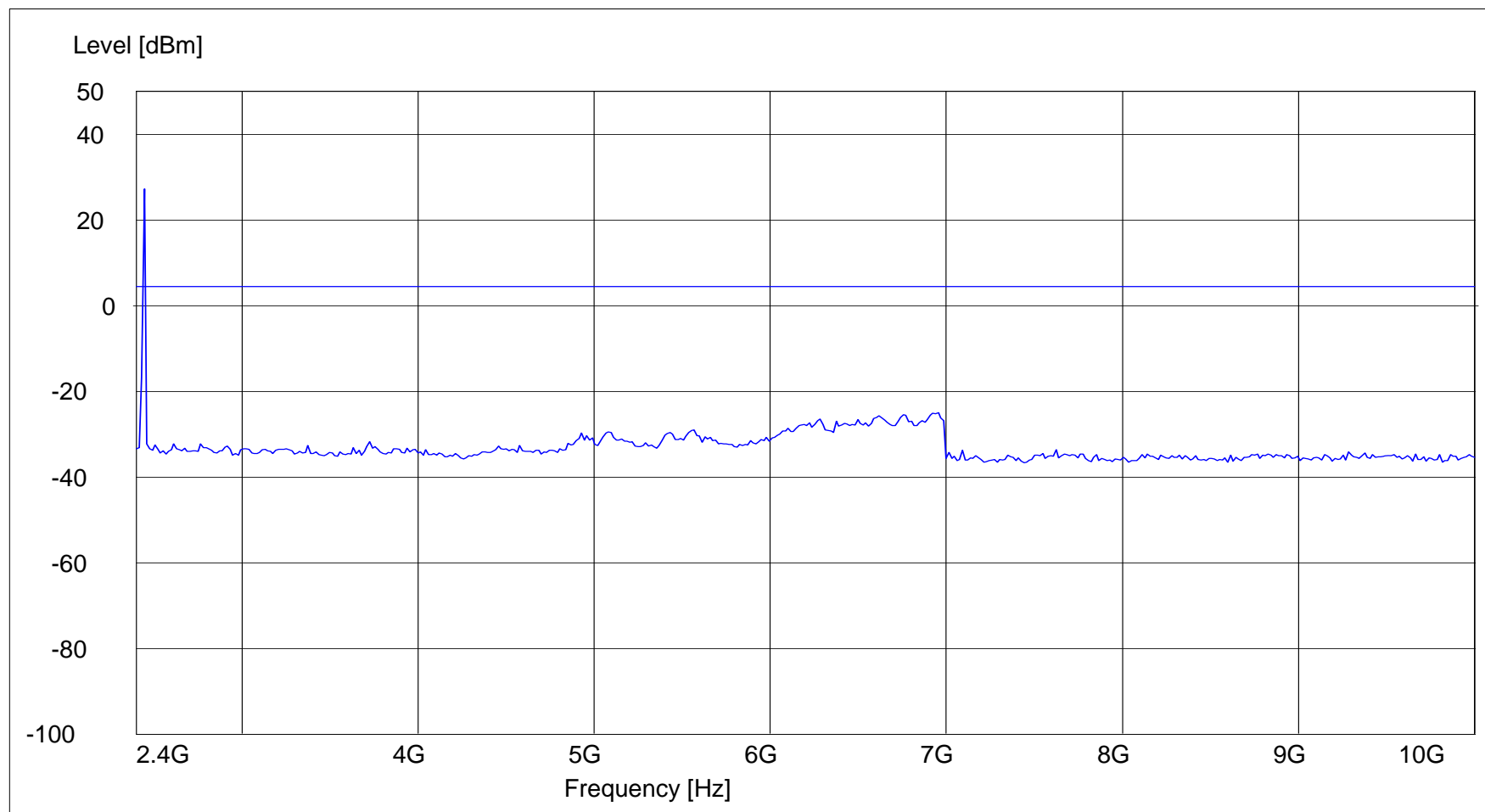
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Test Specification: FCC 15.247 (d)
Mode of Operation: Continuous Modulated Transmission at Discrete Hopping Frequencies
Technician/Date: D.Fiore 05/01/13
Notes: Transmitting on Ch 2



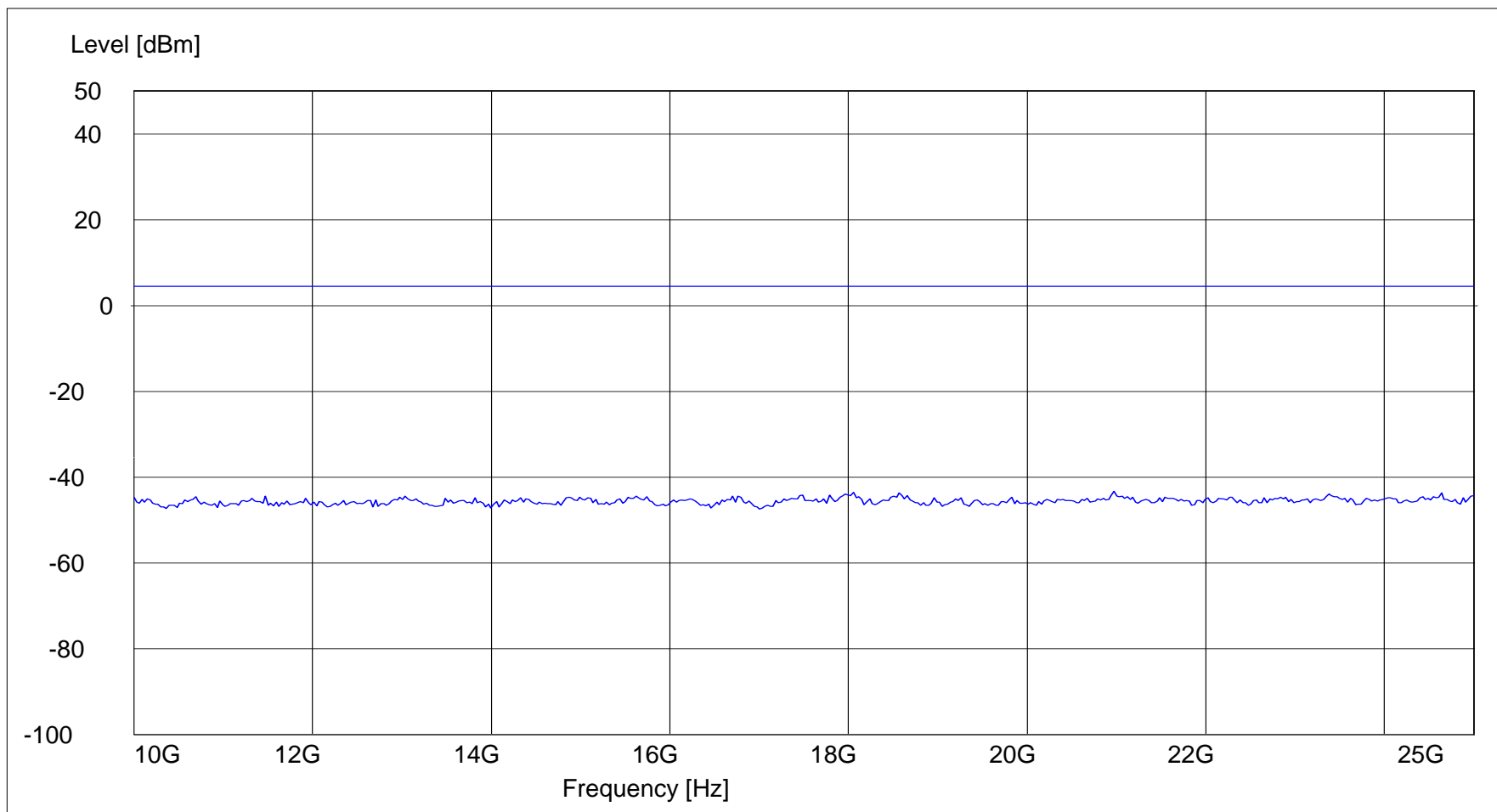
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FCC 15.247 (d) Spurious RF Conducted Emissions

Customer: Sapling, Inc.
Test Sample: Transceiver (Repeater)
Model Number: D-CCA-HPB-24G-1
Test Specification: FCC 15.247 (d)
Mode of Operation: Continuous Modulated Transmission at Discrete Hopping Frequencies
Technician/Date: D.Fiore 05/01/13
Notes: Transmitting on Ch 2



**FCC Section 15.247 (a) / 15.209(a)
Field Strength of Spurious Emissions**

Test Data



Retlif Testing Laboratories

Report No. R-1861P-1



Report No. R-1861P-1

Test Method:	FCC Part 15, Subpart C, Section 15.247 (d), Spurious Radiated Emissions		
Customer:	The Sapling Company	Job No.	R-1861P-1
Test Sample:	Transceiver (Master Clock)		
Model No.:	D-CCA-HPB-24G-1		
Operating Mode:	Transmitting at 2.448 GHz, Hopping Stopped		
Technician:	D.Fiore	Date:	05/2/13

Notes:	Test Distance: 3 Meters Detector: Average RBW / VBW: 1 MHz / 10 Hz Temp:20° RH:23%	* Minimum sensitivity of measurement system, readings taken at 1 meter.
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[illegible]
$$\text{Duty Cycle Correction Factor} = 20 \text{ Log (Dwell Time / 100 mSec)} = 20 \text{ Log (3.0 / 100)}$$


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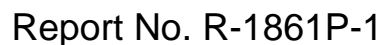


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Notes:	Test Distance: 3 Meters Detector: Peak RBW / VBW: 1 MHz / 3 MHz Temp:20° RH:23% meter.	* Minimum sensitivity of measurement system, readings taken at 1
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Test Method:	FCC Part 15, Subpart C, Section 15.247 (d), Spurious Radiated Emissions		
Customer:	The Sapling Company	Job No.	R-1861P-1
Test Sample:	Transceiver (Repeater)		
Model No.:	D-CCA-HPB-24G-1		
Operating Mode:	Transmitting at 2.44 GHz, Hopping Stopped		
Technician:	D.Fiore	Date:	05/2/13

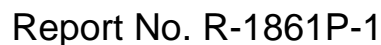
Notes:	Test Distance: 3 Meters Detector: Average RBW / VBW: 1 MHz / 10 Hz Temp:20° RH:23%	* Minimum sensitivity of measurement system, readings taken at 1 meter.
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[illegible]
$$\text{Duty Cycle Correction Factor} = 20 \text{ Log (Dwell Time / 100 mSec)} = 20 \text{ Log (3.0 / 100)}$$


Retlif Testing Laboratories

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Notes:	Test Distance: 3 Meters Detector: Average RBW / VBW: 1 MHz / 10 Hz Temp:20° RH:23% meter.	* Minimum sensitivity of measurement system, readings taken at 1
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$$\text{Duty Cycle Correction Factor} = 20 \log (\text{Dwell Time} / 100 \text{ mSec}) = 20 \log (3.0 / 100)$$


**FCC Section 15.207(a)
Conducted Emissions, Power Leads
150 kHz to 30 MHz**

Test Data

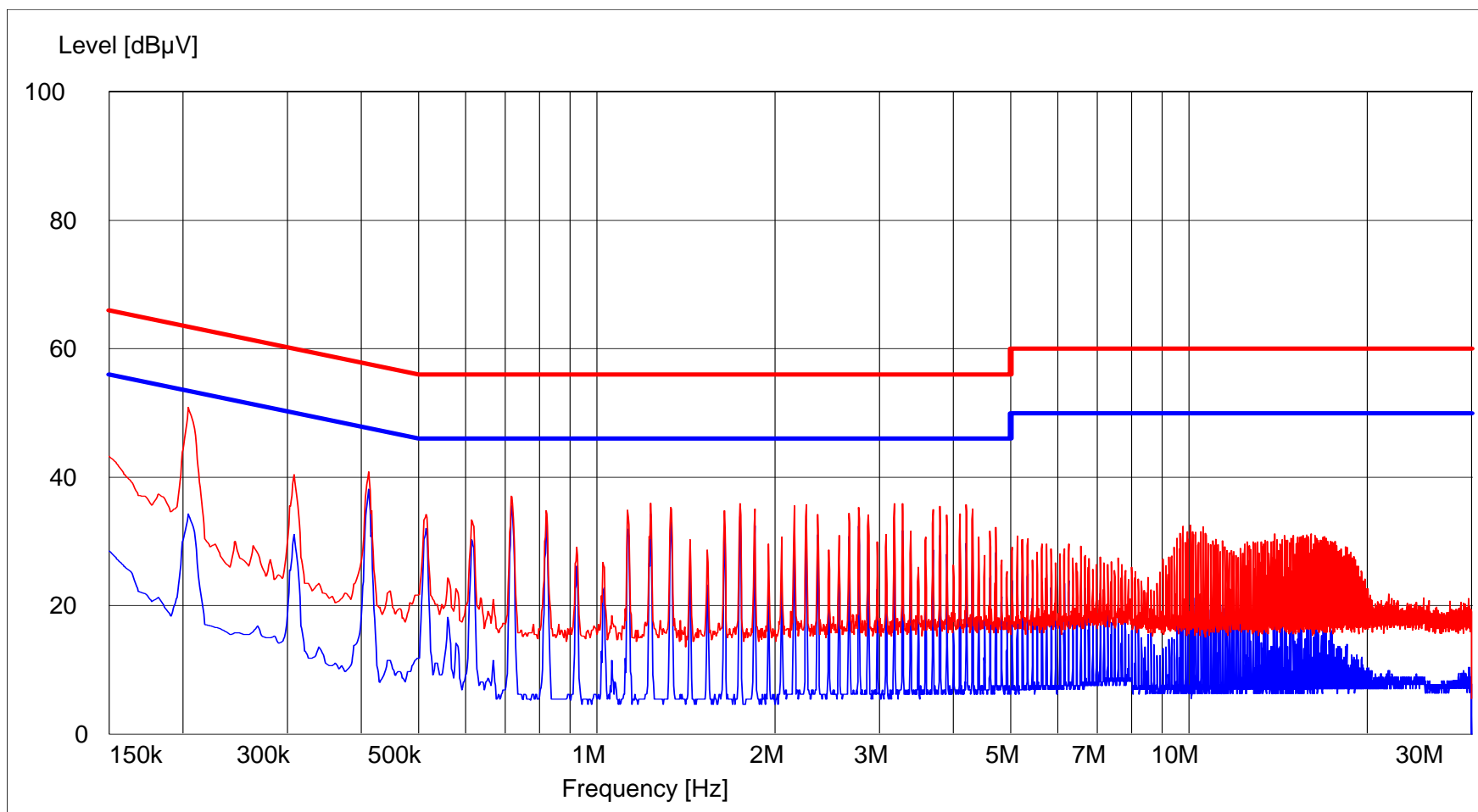


Retlif Testing Laboratories

Report No. R-1861P-1

FCC 15.207 Conducted Emissions 150kHz to 30MHz

Customer: Sapling, Inc.
Test Sample: Transceiver
Model Number: D-CCA-HPB-24G-1
Test Specification: FCC 15.207
Mode of Operation: Continuous Transmission
Technician/Date: D.Fiore 05/03/13
Notes: 120VAC, 60Hz Hot



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FCC 15.207 Conducted Emissions 150kHz to 30MHz

Customer: Sapling, Inc.
Test Sample: Transceiver
Model Number: D-CCA-HPB-24G-1
Test Specification: FCC 15.207
Mode of Operation: Continuous Transmission
Technician/Date: D.Fiore 05/03/13
Notes: 120VAC, 60Hz Neutral

