

Test of WhereCall III+/ WhereCall III+PLC
Class II Permissive Change Test Report

To: FCC 47 CFR Part15.247 & IC RSS-210

Test Report Serial No.: ETSD13-A2 Rev A





Test of WhereCall III+/ WhereCall III+PLC
Class II Permissive Change Test Report
to
FCC 47 CFR Part15.247 & IC RSS-210

Test Report Serial No.: ETSD13-A2 Rev A

This report supersedes: None

Manufacturer: WhereNet
2858 De La Cruz Blvd.
Santa Clara
California 95050, USA

Product Function: RFID and Real Time Local
Positioning and Tracking

Copy No: pdf **Issue Date:** 7th November 2008

This Test Report is Issued Under the Authority of:

MiCOM Labs, Inc.
440 Boulder Court, Suite 200
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CERTIFICATE #2381.01

MiCOM Labs is an ISO 17025 Accredited Testing Laboratory



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ACCREDITATION & LISTINGS

MiCOM Labs, Inc. an accredited laboratory complies with the international standard BS EN ISO/IEC 17025. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.01. MiCOM Labs test schedule is available at the following URL; <http://www.a2la.org/scopepdf/2381-01.pdf>



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LISTINGS

MiCOM Labs test facilities are listed by the following organizations;

North America

United States of America

Federal Communications Commission (FCC) Listing #: 102167

Canada

Industry Canada: 4143A

RECOGNITION

APEC MRA (Asia-Pacific Economic Community Mutual Recognition Agreement)

Conformity Assessment Body (CAB) – MiCOM Labs

Test data generated by MiCOM Labs is accepted in the following countries under the APEC MRA.

Country	Recognition Body	Phase	CAB Identification No.
Australia	Australian Communications and Media Authority (ACMA)	I	US0159
Hong Kong	Office of the Telecommunication Authority (OFTA)	I	
Korea	Ministry of Information and Communication Radio Research Laboratory (RRL)	I	
Singapore	Infocomm Development Authority (IDA)	I	
Taiwan	Directorate General of Telecommunications (DGT) Bureau of Standards, Metrology and Inspection (BSMI)	I I	

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DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft		
Rev A	7 th November 2008	Initial release.

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1. TEST RESULT CERTIFICATE

Manufacturer:	WhereNet	Tested By:	MiCOM Labs, Inc.
	2858 De La Cruz Blvd.		440 Boulder Court
	Santa Clara		Suite 200
	California 95050, USA		Pleasanton
			California, 94566, USA
EUT:	WhereCall III+/ WhereCall III+PLC	Telephone:	+1 925 462 0304
Model:	TFF-2200	Fax:	+1 925 462 0306
S/N:	Not Available		
Test Date(s):	3rd - 4th October 2008	Website:	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part15.247 & IC RSS-210	EQUIPMENT COMPLIES

MiCOM Labs, Inc. tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested is capable of demonstrating compliance with the requirements as documented within this report.

Notes:

1. This document reports conditions under which testing was conducted and the results of testing performed.
2. Details of test methods used have been recorded and kept on file by the laboratory.
3. Test results apply only to the item(s) tested.

Approved & Released for MiCOM Labs, Inc. by:



CERTIFICATE #2381.01



Graeme Grieve
Quality Manager MiCOM Labs,



Gordon Hurst
President & CEO MiCOM Labs, Inc.

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2. REFERENCES AND MEASUREMENT UNCERTAINTY

2.1. Normative References

Ref.	Publication	Year	Title
(i)	FCC 47 CFR Part 15.247	2007	Code of Federal Regulations
(ii)	Industry Canada RSS-210	Issue 7 June 2007	Low Power License-Exempt Radiocommunication Devices (All Frequency Bands)
(iii)	Industry Canada RSS-Gen	Issue 2 June 2007	General Requirements and Information for the Certification of Radiocommunication Equipment.
(iv)	ANSI C63.4	2003	American National Standards for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
(v)	CISPR 22/ EN 55022	Edition 5.2 2006-03	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
(vi)	M 3003	Edition 1 Dec. 1997	Expression of Uncertainty and Confidence in Measurements
(vii)	LAB34	Edition 1 Aug 2002	The expression of uncertainty in EMC Testing
(viii)	ETSI TR 100 028	2001	Parts 1 and 2 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics
(ix)	A2LA	14 th September 2005	Reference to A2LA Accreditation Status – A2LA Advertising Policy

2.2. Test and Uncertainty Procedures

Conducted and radiated emission measurements were conducted in accordance with American National Standards Institute ANSI C63.4, listed in the Normative References section of this report.

Measurement uncertainty figures are calculated in accordance with ETSI TR 100 028 Parts 1 and 2.

Measurement uncertainties stated are based on a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95 % in accordance with UKAS document M 3003 listed in the Normative References section of this report.



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3. PRODUCT DETAILS AND TEST CONFIGURATIONS

3.1. Technical Details

Details	Description
Purpose:	Test of the WhereNet WhereCall III+ / WhereCall III+ PLC to FCC Part 15.247 and Industry Canada RSS-210 regulations as a Class II Permissive Change to tested and certified WhereTag IV, FCC ID: NSQTFF-2000-00AA and IC: 3586B-TFF2000.
Applicant:	As Manufacturer
Manufacturer:	WhereNet 2858 De La Cruz Blvd. Santa Clara California 95050, USA
Laboratory performing the tests:	MiCOM Labs, Inc. 440 Boulder Court, Suite 200 Pleasanton, California 94566 USA
Test report reference number:	ETSD13-A2 Rev A
Date EUT received:	3rd October 2008
Standard(s) applied:	FCC 47 CFR Part15.247 & IC RSS-210
Dates of test (from - to):	3rd - 4th October 2008
No of Units Tested:	2
Type of Equipment:	DSSS/OOK/802.11b RFID Active Tag
Manufacturers Trade Name:	WhereCall III+/ WhereCall III+PLC
Model:	TFF-2200
Location for use:	Indoor/Outdoor use
Declared Frequency Range(s):	2400 - 2483.5 MHz
Type of Modulation:	DSSS, OOK, CCK
Declared Nominal Output Power:	DSSS: +13 $\pm$ 1.5 dBm OOK: -1.5 $\pm$ 1.5 dBm 802.11b: +10 $\pm$ 1.5 dBm
EUT Modes of Operation:	DSSS, OOK, 802.11b
Transmit/Receive Operation:	Time Division Duplex
Rated Input Voltage and Current:	3.6 Vdc, 200 mA
Operating Temperature Range:	Declared range -40 to +85°C
ITU Emission Designator:	DSSS – 67M3W7D OOK – 10M3W7D 802.11b – 15M9W7D
Microprocessor(s) Model:	Integrated LEON SPARC
Clock/Oscillator(s):	32.768 kHz, 44.00 MHz
Frequency Stability:	$\pm$ 20 ppm
Equipment Dimensions:	4.7" x 3.0" x 1.6"
Weight:	170 grams
Primary function of equipment:	RFID and real time local positioning and tracking device

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3.2. Scope of Test Program

The scope of the test program was to test the WhereNet WhereCall III+ / WhereCall III+ PLC to FCC Part 15.247 and Industry Canada RSS-210 specifications as a Class II Permissive Change to tested and certified WhereTag IV, FCC ID: NSQTFF-2000-00AA and IC: 3586B-TFF2000.

The WhereCall III+ and WhereCall III+ PLC models are identical; the WhereCall III+ has an integral call button built into it's front panel, the WhereCall III+ PLC has a remote call button that plugs via a cable into the front panel. All conducted testing was performed on the WhereCall III+, all radiated testing was performed on the WhereCall+ PLC as this configuration represents the worst case for radiated emissions.

The WhereCall III+/WhereCall+ PLC has three modes of operation which are not operating simultaneously;

- DSSS: 2441.75 MHz
- OOK: 2446.519 MHz
- 802.11b: 2412 – 2462 MHz

WhereNet WhereCall III+



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WhereNet WhereCall III+ PLC



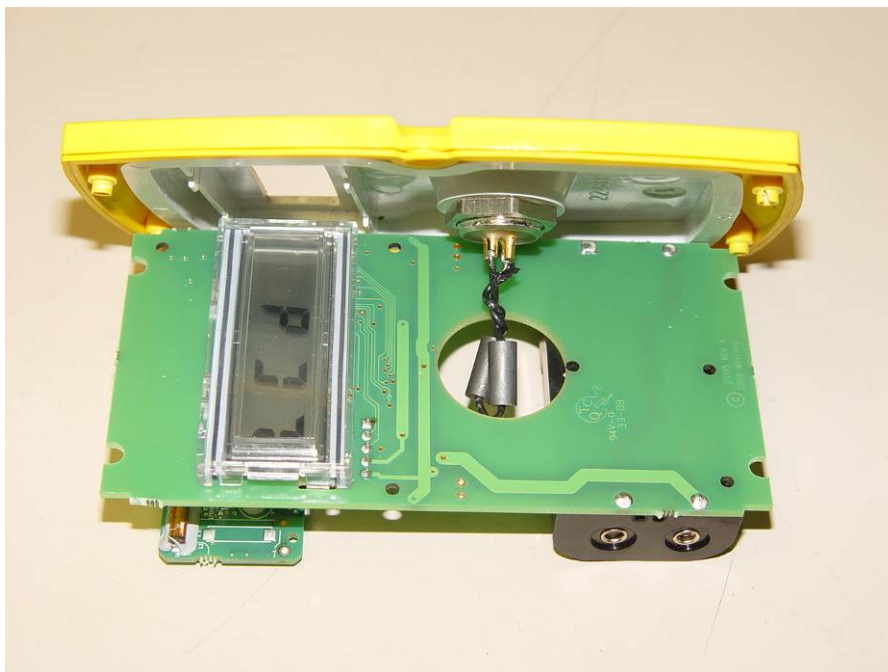
WhereNet WhereCall III+ PLC with remote activation button



WhereNet WhereCall III+ Internal



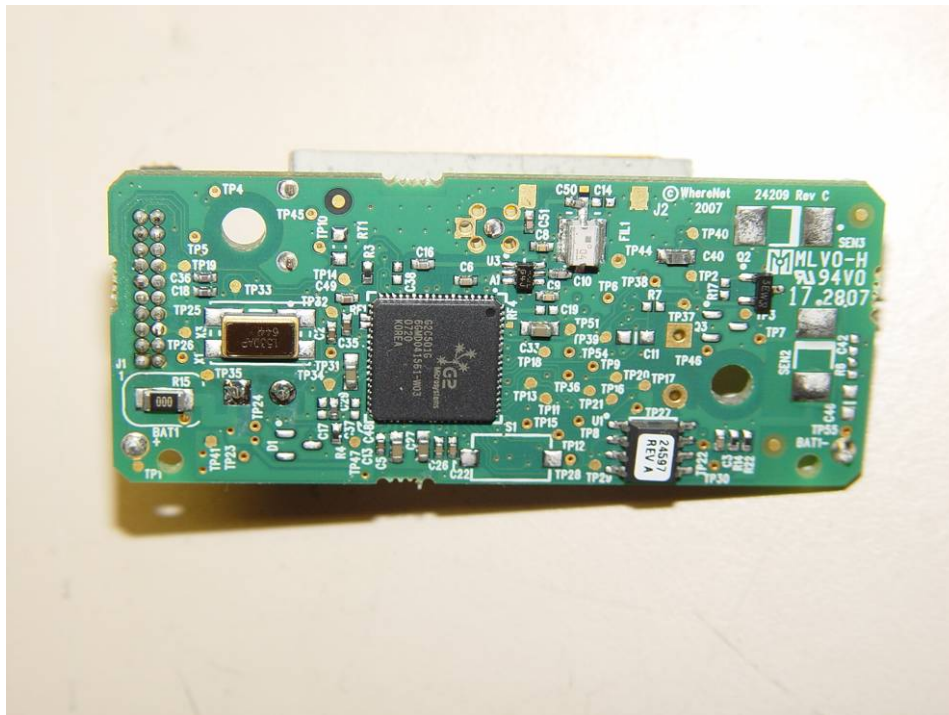
WhereNet WhereCall III+ Internal



WhereNet WhereCall III+ RFID Tag Top



WhereNet WhereCall III+ RFID Tag Bottom





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3.3. Equipment Model(s) and Serial Number(s)

Type (EUT/ Support)	Equipment Description (Manufacturer and Product Name)	Model No.	Part Number	Serial No.
EUT (Conducted)	WhereNet WhereCall III+	TFF-2200	TFF-2200-00AA	--
EUT (Radiated)	WhereNet WhereCall III+PLC	TFF-2200	TFF-2201-00AA	--
Support	Sony Laptop PC	VAIO		--

3.4. Antenna Details

Antenna Type	Gain (dBi)	Manufacturer	Model No.	Serial No.
Inverted F	-1.0 max	WhereNet	10370	--

3.5. Cabling and I/O Ports

Number and type of I/O ports

1. Cable with remote button activation.

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3.6. Test Configurations

Matrix of test configurations

Operational Mode	# Operating Channel(s)	Nominal Tx Pwr (dBm)	Frequencies (MHz)
DSSS	1	+13.0	2441.75
OOK	1	-1.5	2446.519
802.11b	3	+10.0	2412, 2437, 2462

Only worst case plots are provided for each test parameter are identified within this report. Plots not included are held on file by the test laboratory and available upon request with client permission.

There were two types of RFID tag used for test purposes;

- 1) conducted testing – WhereCall III+ with 100% duty cycle
- 2) radiated testing – WhereCall III+ PLC with 100% duty cycle

Although the same physical device was used for both radiated and conducted testing it required modification i.e. soldering an SMA connector to the pcb

3.7. Equipment Modifications

The following modifications were required to bring the equipment into compliance:

1. None

3.8. Deviations from the Test Standard

The following deviations from the test standard were required in order to complete the test program:

1. NONE



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4. TEST SUMMARY

List of Measurements

The following table represents the list of measurements required under the **FCC CFR47 Part 15.247** and **Industry Canada RSS-210** and **Industry Canada RSS-Gen**.

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.247(a)(2) A8.2(1) 4.4	6 dB and 99 % Bandwidths	>=500 kHz	Conducted	Complies	5.1.1
15.247(b)(3) 15.31(e) A8.4(4)	Peak Output Power Voltage Variation	Shall not exceed 1W Variation of supply voltage 85 % -115 %	Conducted	Complies	5.1.2
15.247(e) A8.2	Peak Power Spectral Density	Shall not be greater than +8 dBm in any 3 kHz band	Conducted	Complies	5.1.3
15.247(d) 15.205 / 15.209 A8.5 2.2 4.7	Spurious Emissions (30MHz - 26 GHz)	The radiated emission in any 100 kHz of out-band shall be at least 20 dB below the highest in-band spectral density	Conducted	Complies	5.1.4

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List of Measurements (continued)

The following table represents the list of measurements required under the **FCC CFR47 Part 15.247**, **Industry Canada RSS-210**, and **Industry Canada RSS-Gen**.

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.247(d) 15.205 / 15.209 A8.5 2.2 2.6 4.7 Industry Canada only RSS-Gen §4.8, §6	Radiated Emissions	Restricted Bands	Radiated	Complies	5.1.5
	Transmitter Radiated Spurious Emissions, Peak Emissions, Band Edge	Emissions above 1 GHz		Complies	5.1.5.1
	Receiver Radiated Spurious Emissions	Emissions above 1 GHz		Complies	5.1.5.2
15.205 / 15.209 2.2	Radiated Spurious Emissions	Emissions <1 GHz (30M-1 GHz)	Radiated	Complies	5.1.5.3
15.207 7.2.2	AC Wireline Conducted Emissions 150 kHz–30 MHz	Conducted Emissions	Conducted	Not Applicable Device dc powered	5.1.6

Note 1: Test results reported in this document relate only to the items tested

Note 2: The required tests demonstrated compliance as per client declaration of test configuration, monitoring methodology and associated pass/fail criteria

Note 3: Appendix A - Equipment Modifications highlights the equipment modifications that were required to bring the product into compliance with the above test matrix

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5. TEST RESULTS

5.1. Device Characteristics

5.1.1. 6 dB and 99 % Bandwidth

FCC, Part 15 Subpart C §15.247(a)(2)

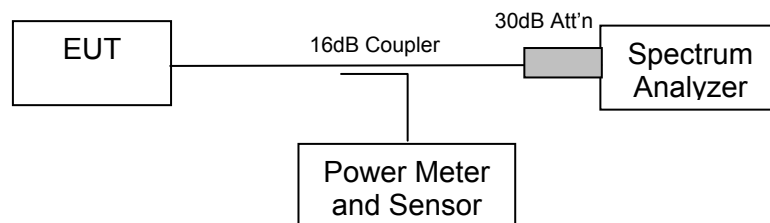
Industry Canada RSS-210 §A8.2

Industry Canada RSS-Gen §4.4

Test Procedure

The bandwidth at 6 dB and 99 % is measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate center frequency. The analyzer was set for a 6 dB resolution bandwidth filter during this measurement.

Test Measurement Set up



Measurement set up for 6 dB and 99 % bandwidth test



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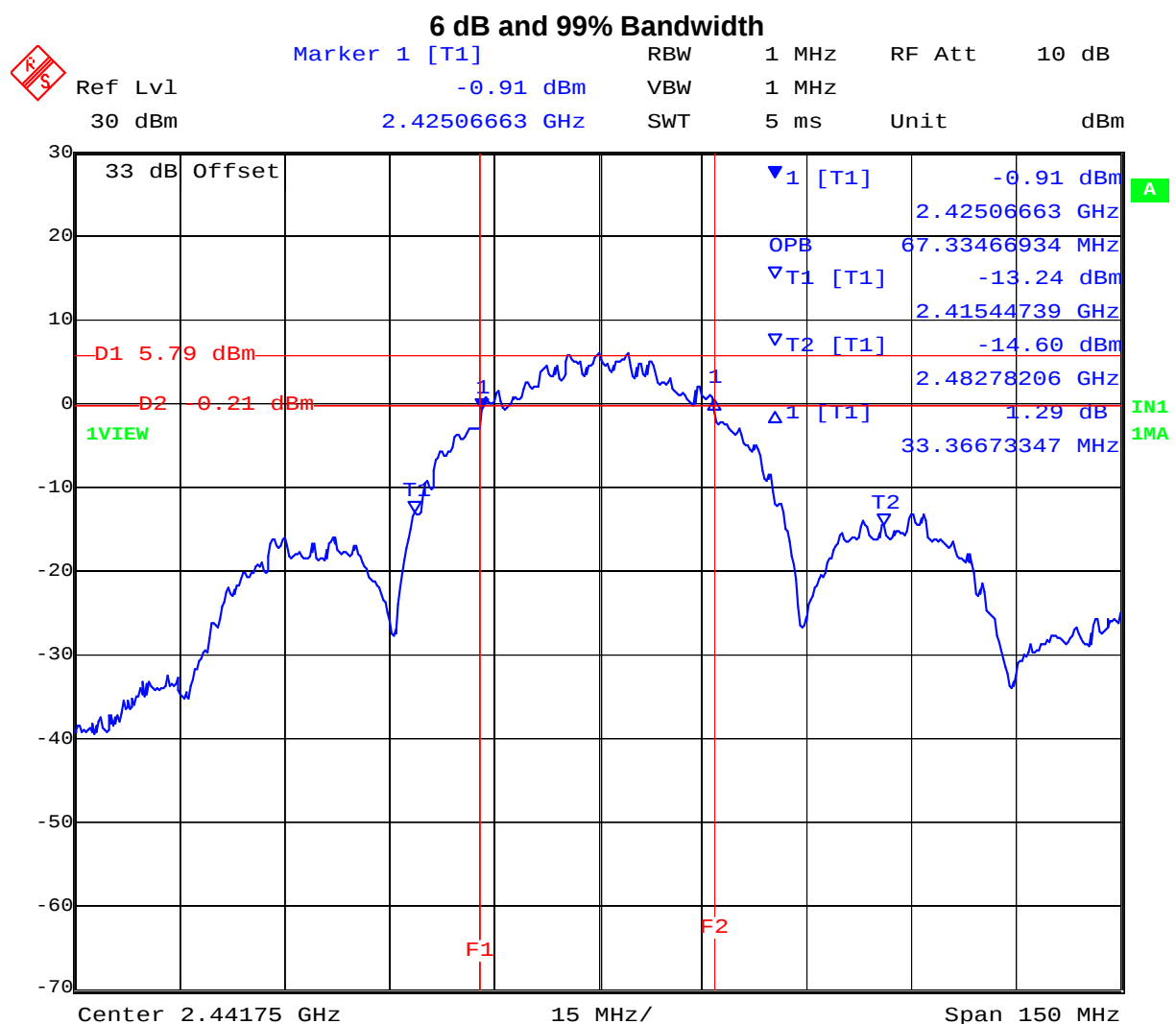
Measurement Results for 6 dB and 99 % Operational Bandwidth(s)

Ambient conditions.

Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

TABLE OF RESULTS – DSSS

Center Frequency (MHz)	6 dB Bandwidth (MHz)	99 % BW (MHz)
2441.75	33.3667	67.3347



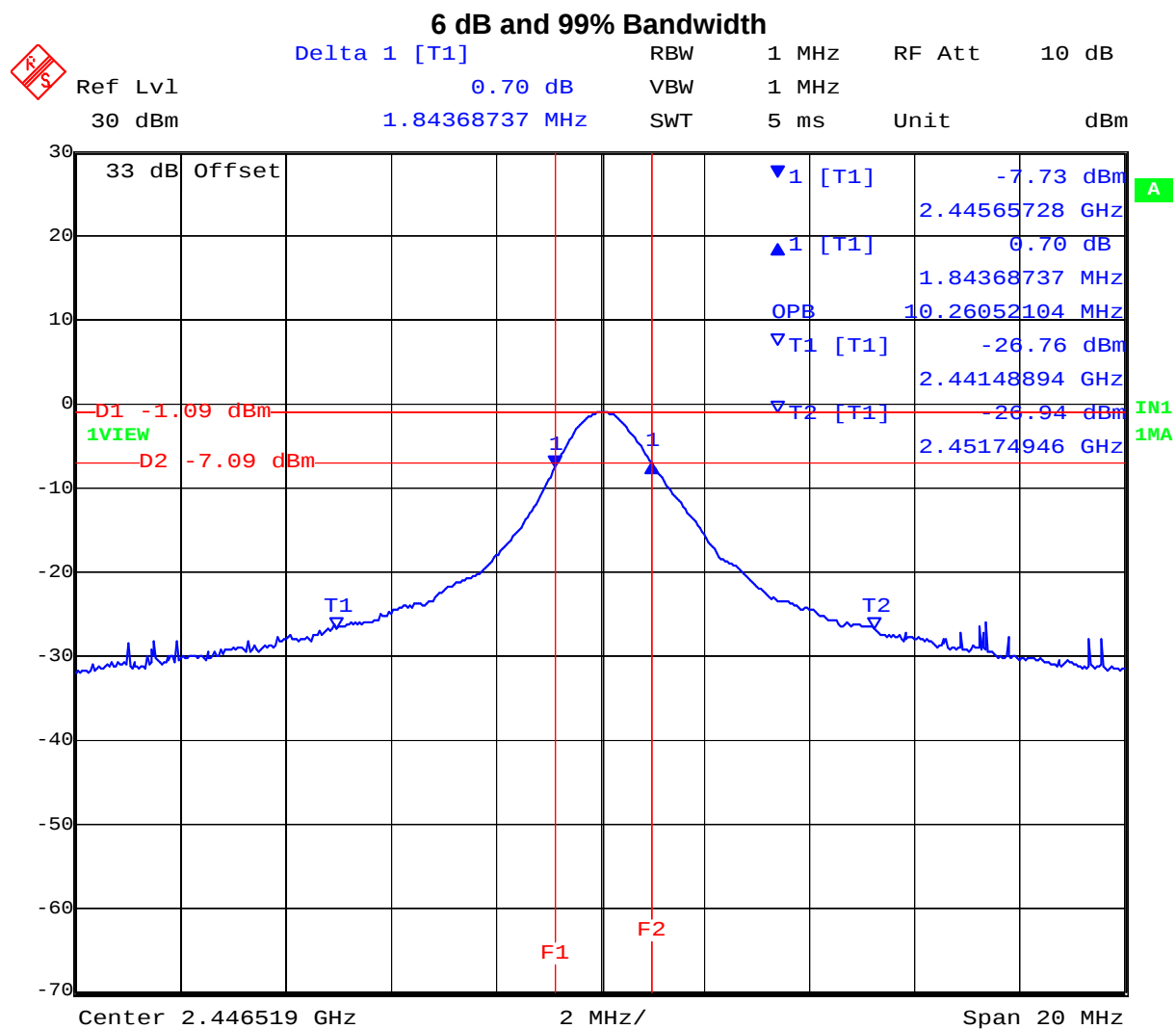
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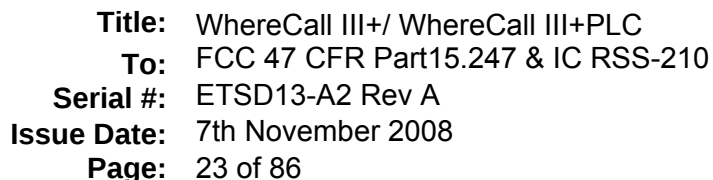
Title: WhereCall III+/ WhereCall III+PLC
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TABLE OF RESULTS – OOK

Center Frequency (MHz)	6 dB Bandwidth (MHz)	99 % BW (MHz)
2446.519	1.8437	10.2605



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Center Frequency (MHz)	6 dB Bandwidth (MHz)	99 % BW (MHz)
2412	10.9018	15.8717
2437	10.7415	15.8717
2462	10.7415	15.8717

The screenshot displays a Spectrum Analyzer interface with the following details:

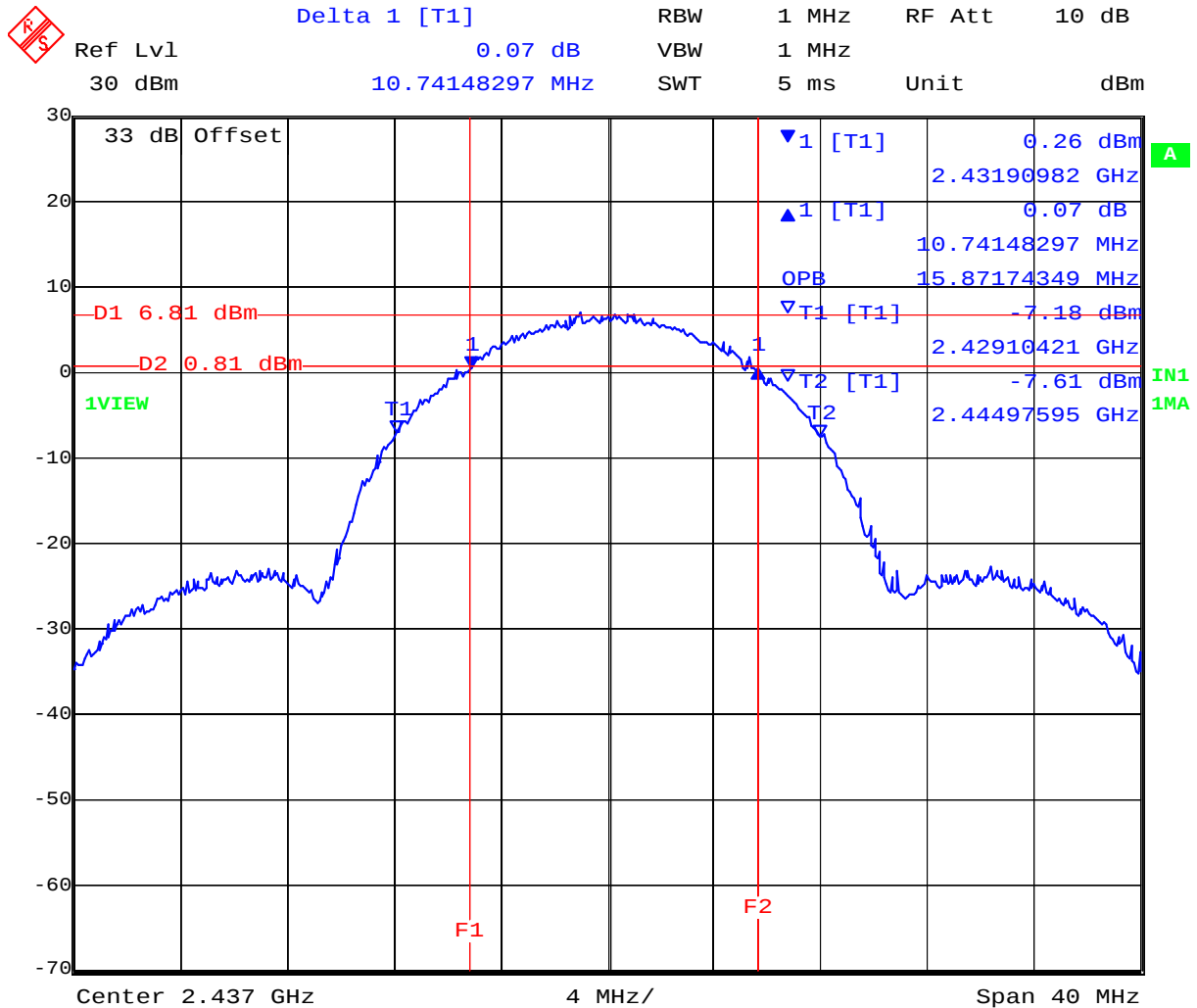
- Top Panel:**
 - Reference Level (Ref Lvl): 33 dBm
 - Delta 1 [T1]: 0.22 dB
 - Resolution Bandwidth (RBW): 1 MHz
 - Video Bandwidth (VBW): 5 ms
 - RF Attenuation (RF Att): 10 dB
 - Unit: dBm
- Plot Area:**
 - Y-axis: Power in dBm, ranging from -70 to 30.
 - X-axis: Frequency in GHz, ranging from 2.4 to 2.5 GHz.
 - Signal Trace: A blue line representing the spectrum, showing a peak around 2.412 GHz.
 - Cursors: Two vertical red cursors labeled F1 and F2 are positioned at approximately 2.4066934 GHz and 2.41997595 GHz, respectively.
 - Horizontal Red Lines: Two lines labeled D1 (6.82 dBm) and D2 (0.82 dBm) are shown across the plot.
 - Annotations: '1VIEW' is displayed in green on the left side of the plot.
- Right Panel:**
 - Measurement 1 (▼1 [T1]): 0.58 dBm, 2.40666934 GHz.
 - Measurement 2 (▲1 [T1]): 0.22 dB, 10.90180361 MHz.
 - Measurement 3 (▽T1 [T1]): -7.28 dBm, 2.40410421 GHz.
 - Measurement 4 (▽T2 [T1]): -7.01 dBm, 2.41997595 GHz.
 - Other labels: OPB, 15.87174349 MHz.
- Bottom Panel:**
 - Center Frequency: 2.412 GHz
 - Span: 40 MHz

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2437 MHz 6 db and 99 % Bandwidth

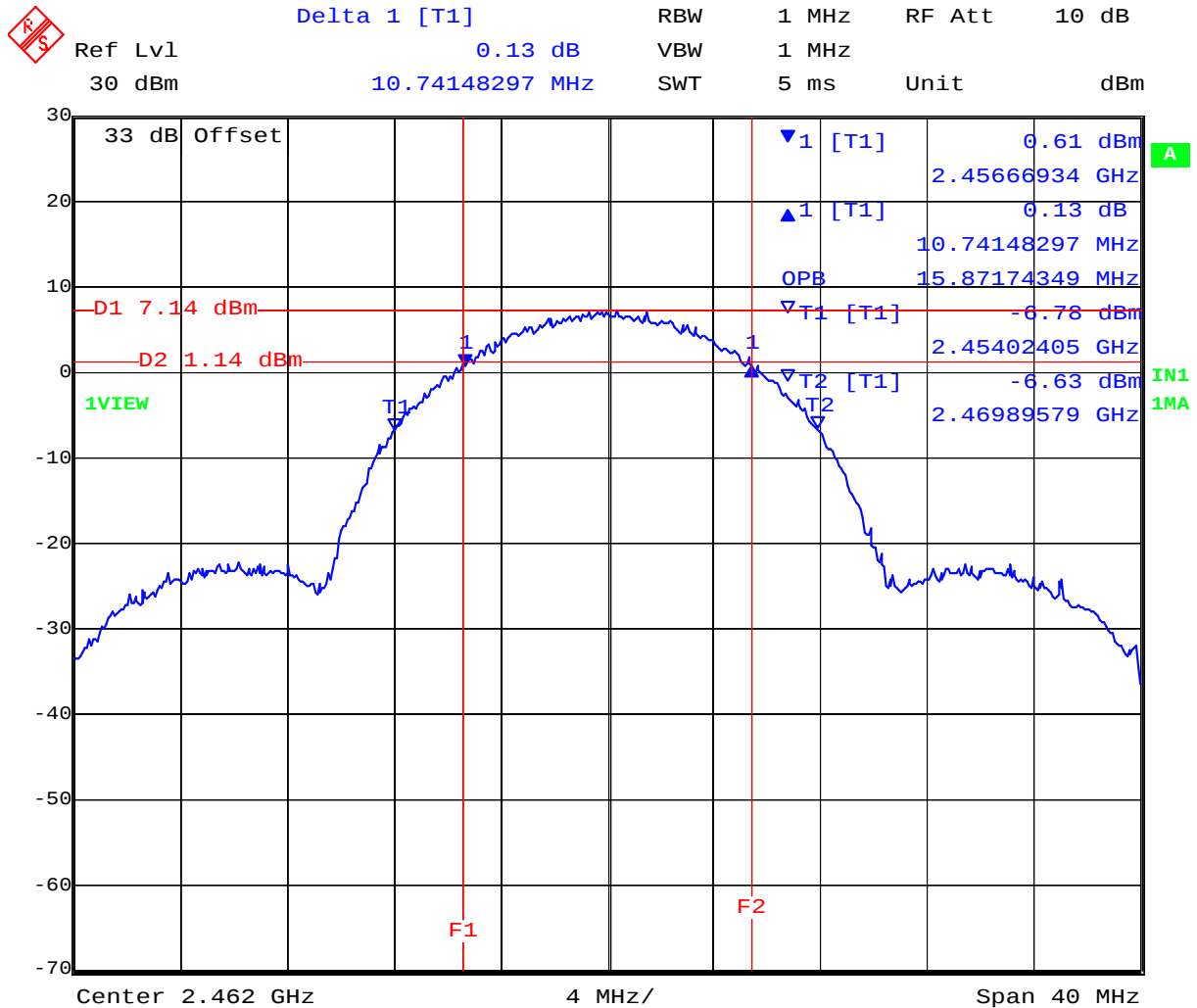


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2462 MHz 6 dB and 99% Bandwidth



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Specification

Limits

§15.247 (a)(2) & RSS-210 §A8.2(1)

The minimum 6 dB bandwidth shall be at least 500 kHz.

§ IC RSS-Gen 4.4.1 Occupied Bandwidth When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.

§ IC RSS-Gen 4.4.2 6 dB Bandwidth Where indicated, the 6 dB bandwidth is measured at the points when the spectral density of the signal is 6 dB down from the in –band spectral density of the modulated signal, with the transmitter modulated by a representative signal.

Laboratory Measurement Uncertainty for Spectrum Measurement

Measurement uncertainty	±2.81 dB
-------------------------	----------

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of RF Spectrum Mask'	0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117

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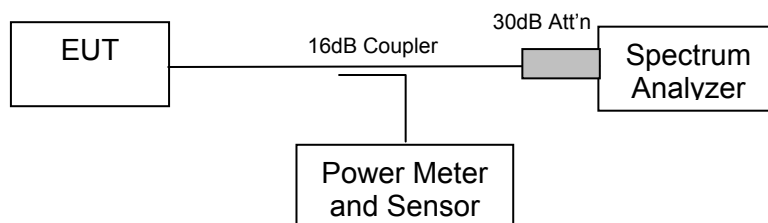
5.1.2. Peak Output Power

FCC, Part 15 Subpart C §15.247(b)(3), §15.31(e)
 Industry Canada RSS-210 §A8.4(4)

Test Procedure

The transmitter terminal of EUT was connected to the input of the spectrum analyzer set to measure peak power. The resolution filter bandwidth was set to 6 dB, peak detector selected and the analyzer built-in power function was used to measure peak power over the 99 % bandwidth. Initial measurements were employed to define which data rate provided the highest output power. Measurements were made while EUT was operating in a continuous transmission mode i.e. 100 % duty cycle at the appropriate center frequency.

Test Measurement Set up



Measurement set up for Transmitter Peak Output Power

15.247 (c) Operation with directional antenna gains greater than 6 dBi

(1) Fixed point –to-point operation:

(i) Systems operating in the 2400 – 2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(ii) Systems operating in the 5725-5850 MHz band that are used exclusively for point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

Antenna Type	Gain (dBi)	Antenna Gain >6dBi (dB)	Max. Allowable Peak Power (dBm)	Maximum EIRP (dBm)
Integral	-1.0	No	30	36



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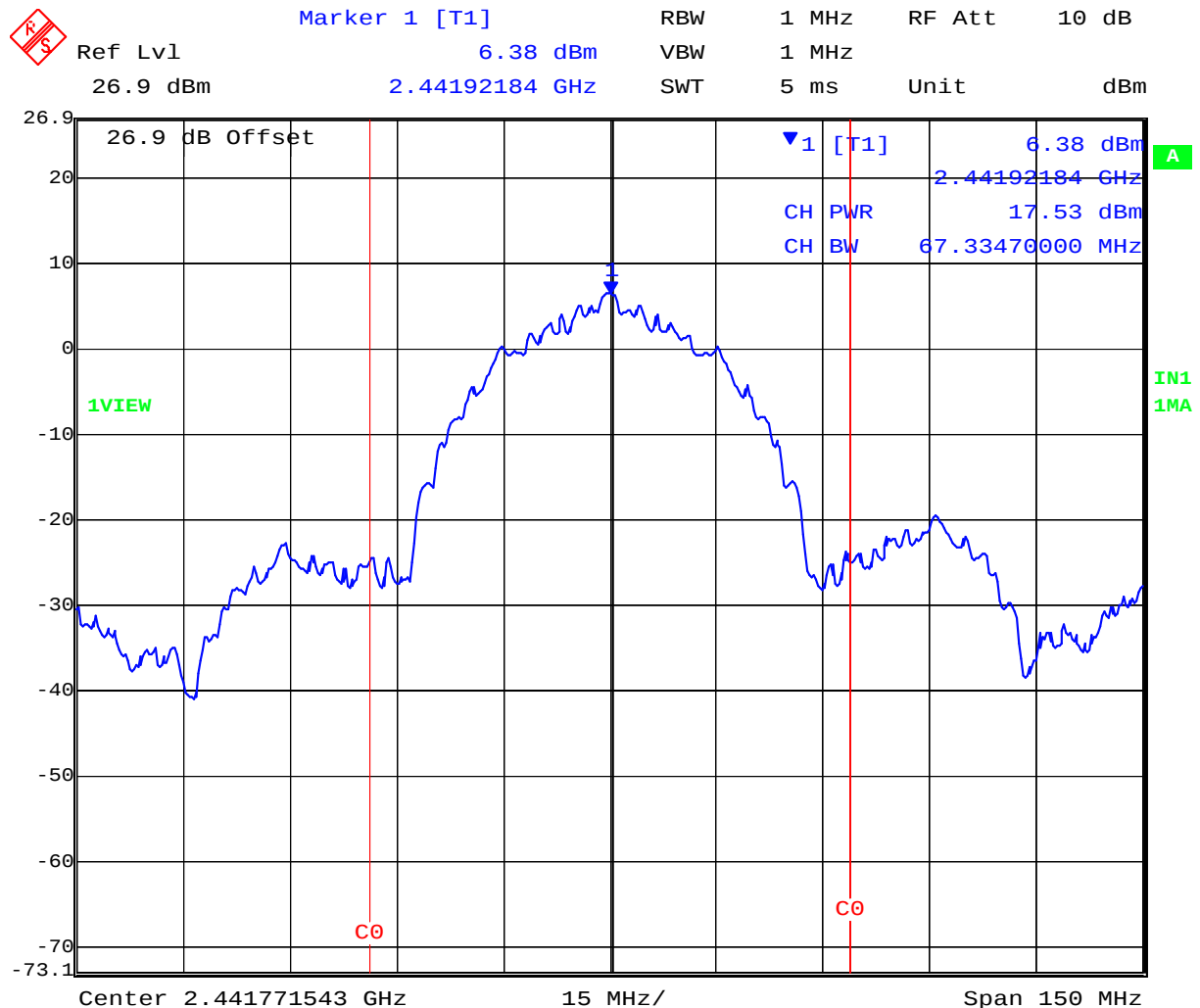
Ambient conditions.

Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

TABLE OF RESULTS – DSSS

Center Frequency (MHz)	99% Measurement Bandwidth (MHz)	Peak Power (dBm)	EIRP (dBm)
2441.75	67.3347	+17.53	+16.53

2441.75 MHz Peak Power (dBm)



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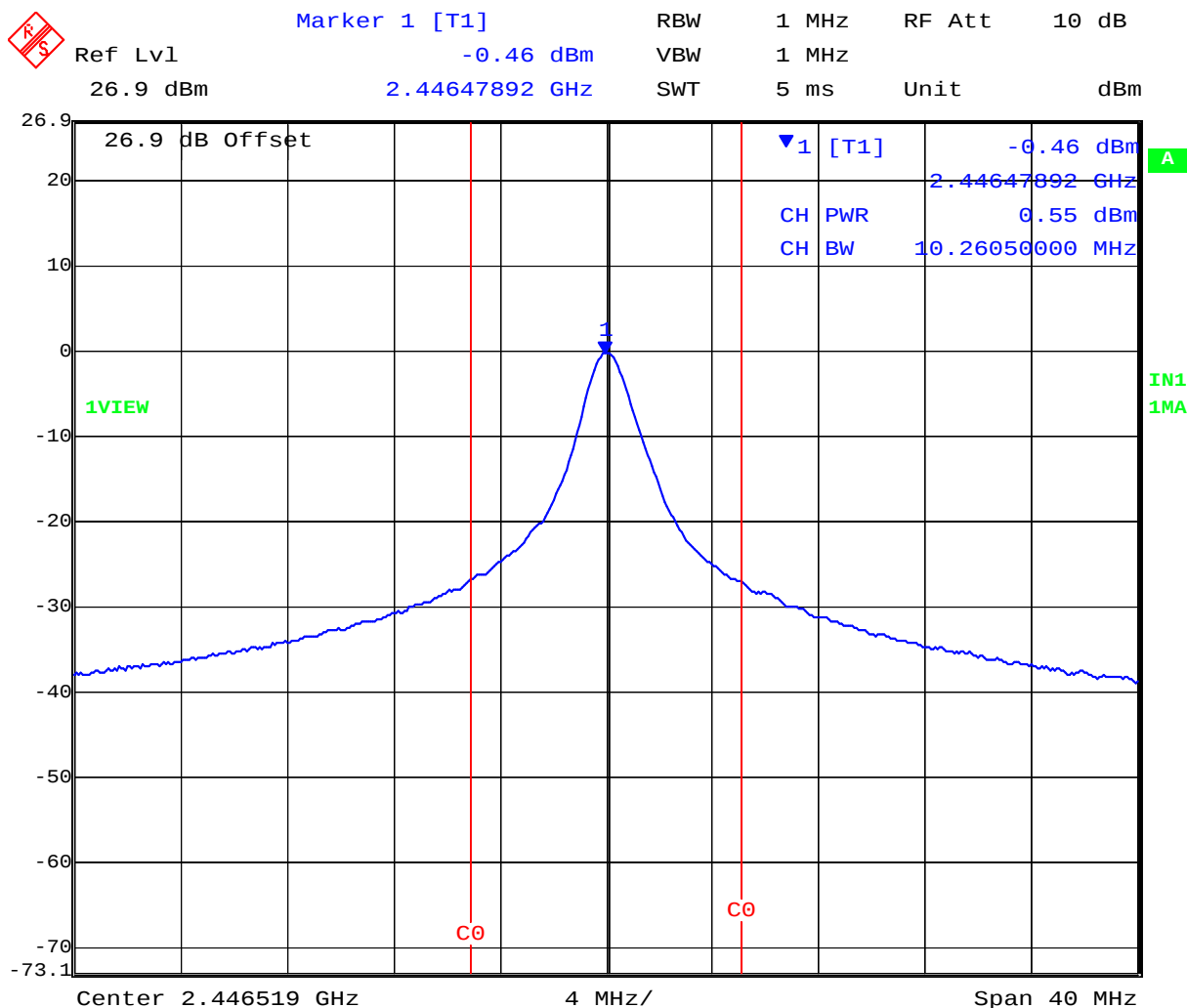


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TABLE OF RESULTS – OOK

Center Frequency (MHz)	99% Measurement Bandwidth (MHz)	Peak Power (dBm)	EIRP (dBm)
2446.519	10.2605	+0.55	-0.45

2446.519 MHz Peak Power (dBm)



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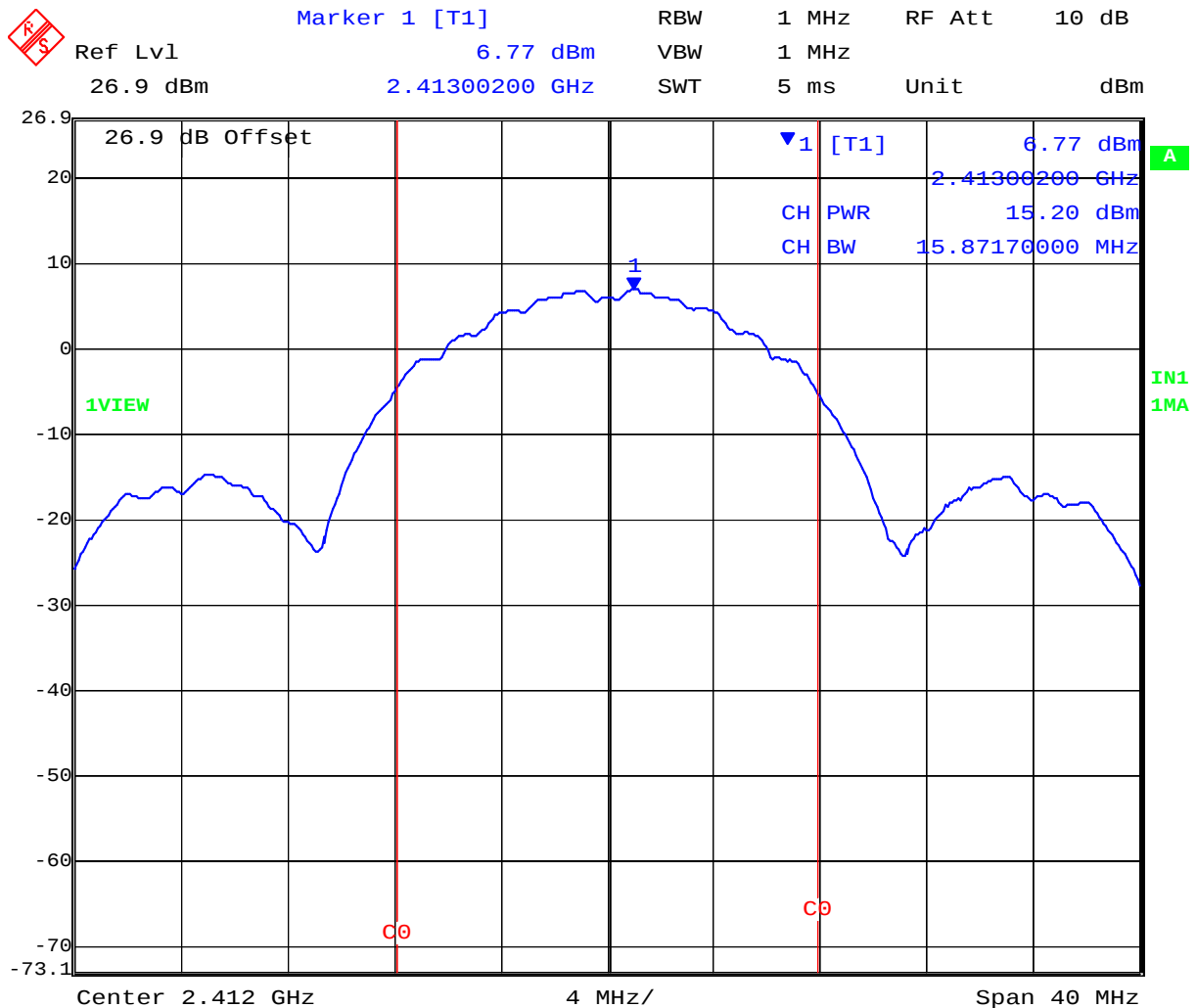


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TABLE OF RESULTS – 802.11b

Center Frequency (MHz)	99%Measurement Bandwidth (MHz)	Peak Power (dBm)	EIRP (dBm)
2,412	15.8717	+15.20	+14.20
2,437	15.8717	+15.19	+14.19
2,462	15.8717	+15.09	+14.09

2,412 MHz 802.11b Peak Power (dBm)



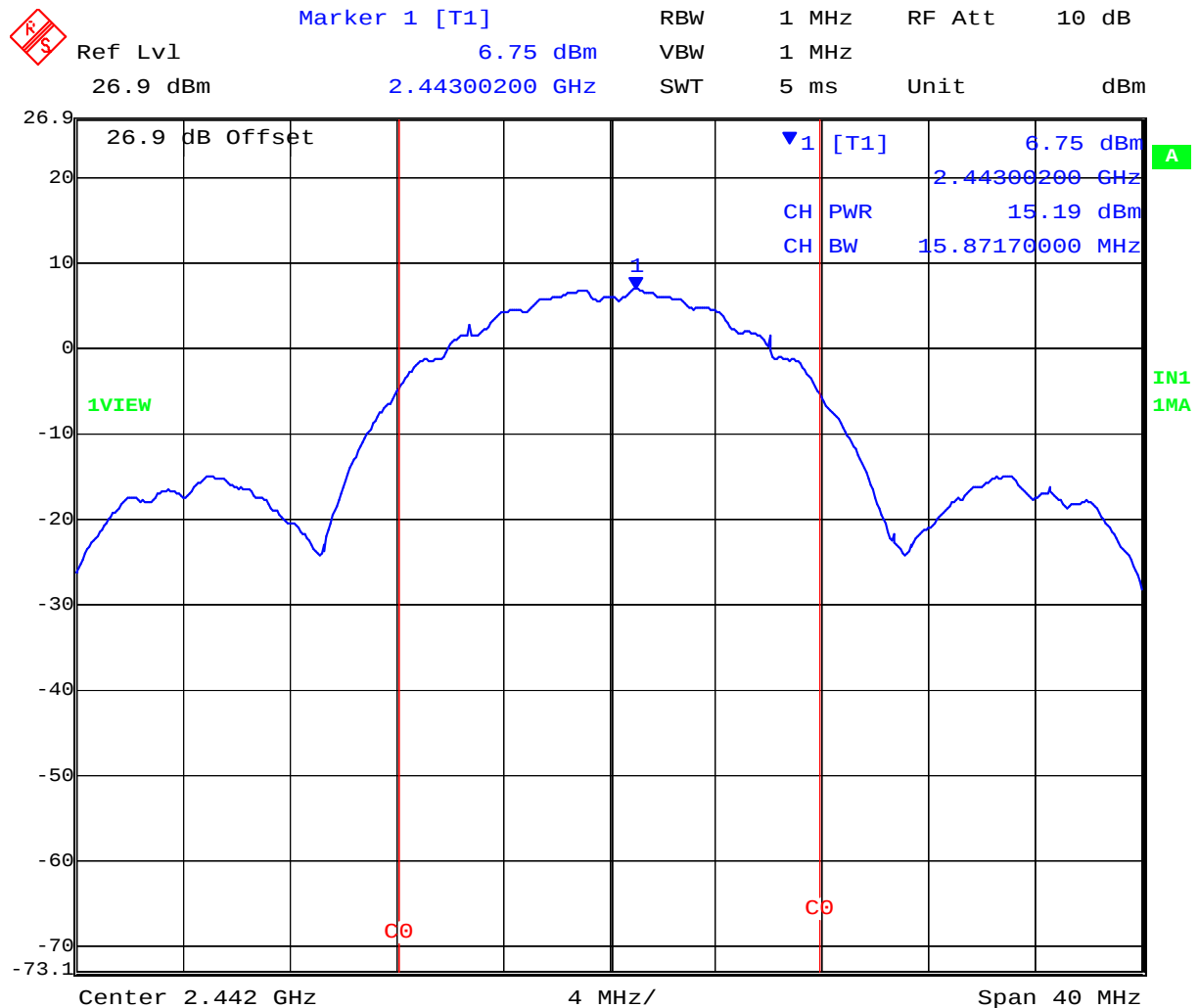
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TABLE OF RESULTS – 802.11b

2,437 MHz 802.11b Peak Power (dBm)



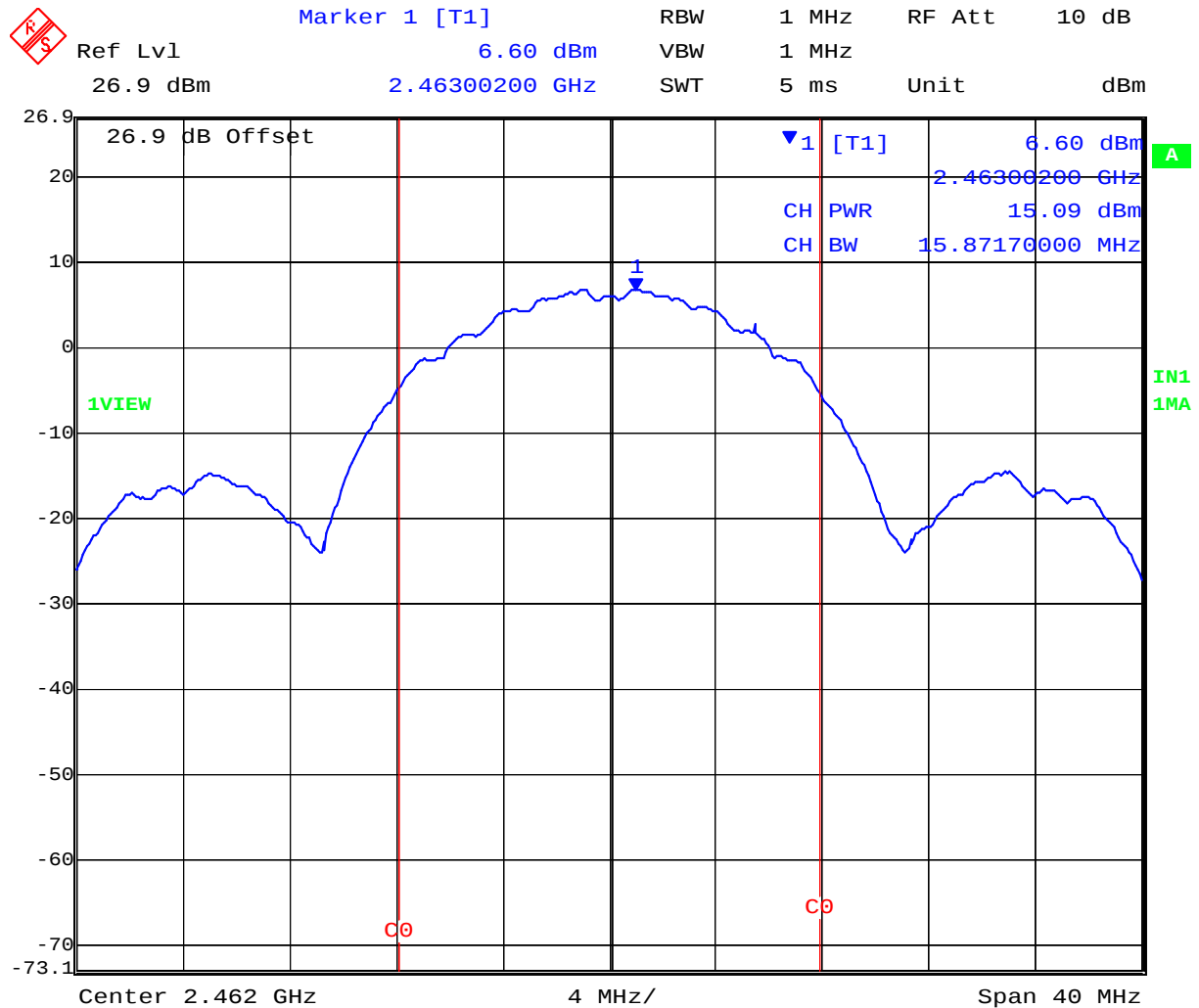
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TABLE OF RESULTS – 802.11b

2,462 MHz 802.11b Peak Power (dBm)



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Supply Voltage Variation

The supply voltage was varied 15% between 3.06 Vdc and 3.96 Vdc. The system operated as intended at either extreme with no change in the above measurement bandwidths.

Specification

Limits

§15.247 (b) The maximum peak output power of the intentional radiator shall not exceed the following:

§15.247 (b) (3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands: 1.0 watt.

§15.31 (e) For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the 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.

§ RSS-210 A8.4(4) For systems employing digital modulation techniques operating in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands the maximum peak conducted power shall not exceed 1 watt.

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33 dB
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Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117

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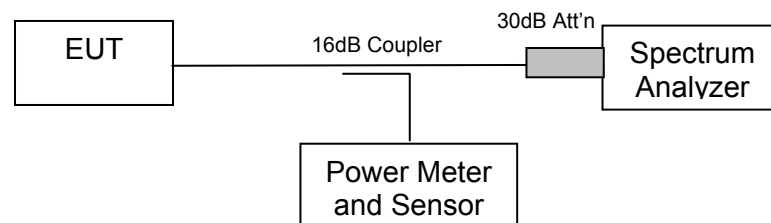
5.1.3. Peak Power Spectral Density

FCC, Part 15 Subpart C §15.247(e)
Industry Canada RSS-210 §A8.2

Test Procedure

The transmitter output was connected to a spectrum analyzer and the maximum level in a 3 kHz bandwidth was measured. A peak value was found over the full emission bandwidth and the frequency span reduced to obtain enhanced resolution. Sweep time => span / 3 kHz with video averaging turned off. The Peak Power Spectral Density is the highest level found across the emission in a 3 kHz resolution bandwidth. Spectrum analyzer settings:

Test Measurement Set up



Measurement set up for Peak Power Spectral Density

Measurement Results for Peak Power Spectral Density

Ambient conditions.

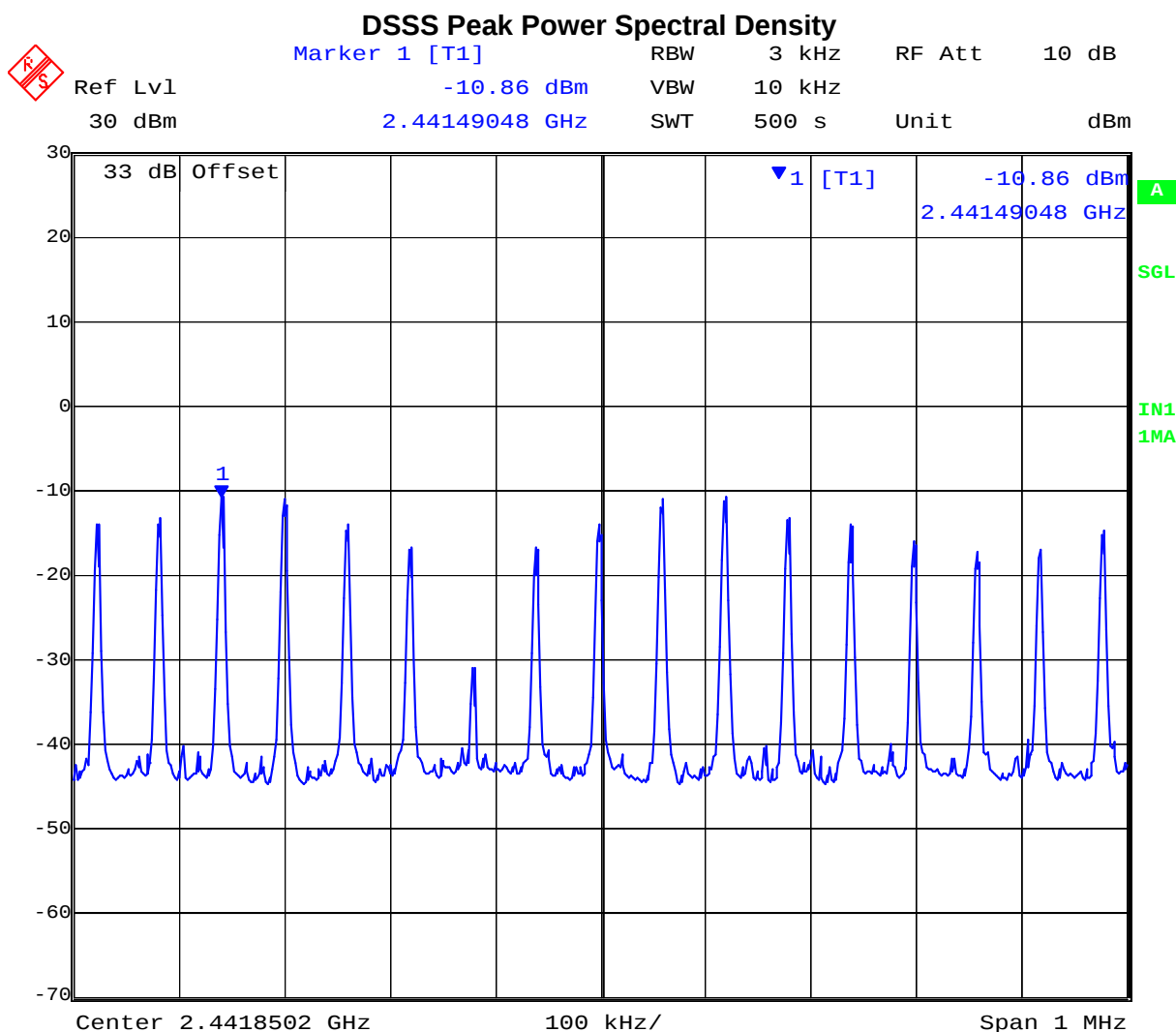
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar



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TABLE OF RESULTS – DSSS

Center Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin (dBm)
2,441.75	2441.49048	-10.86	+8	-18.86



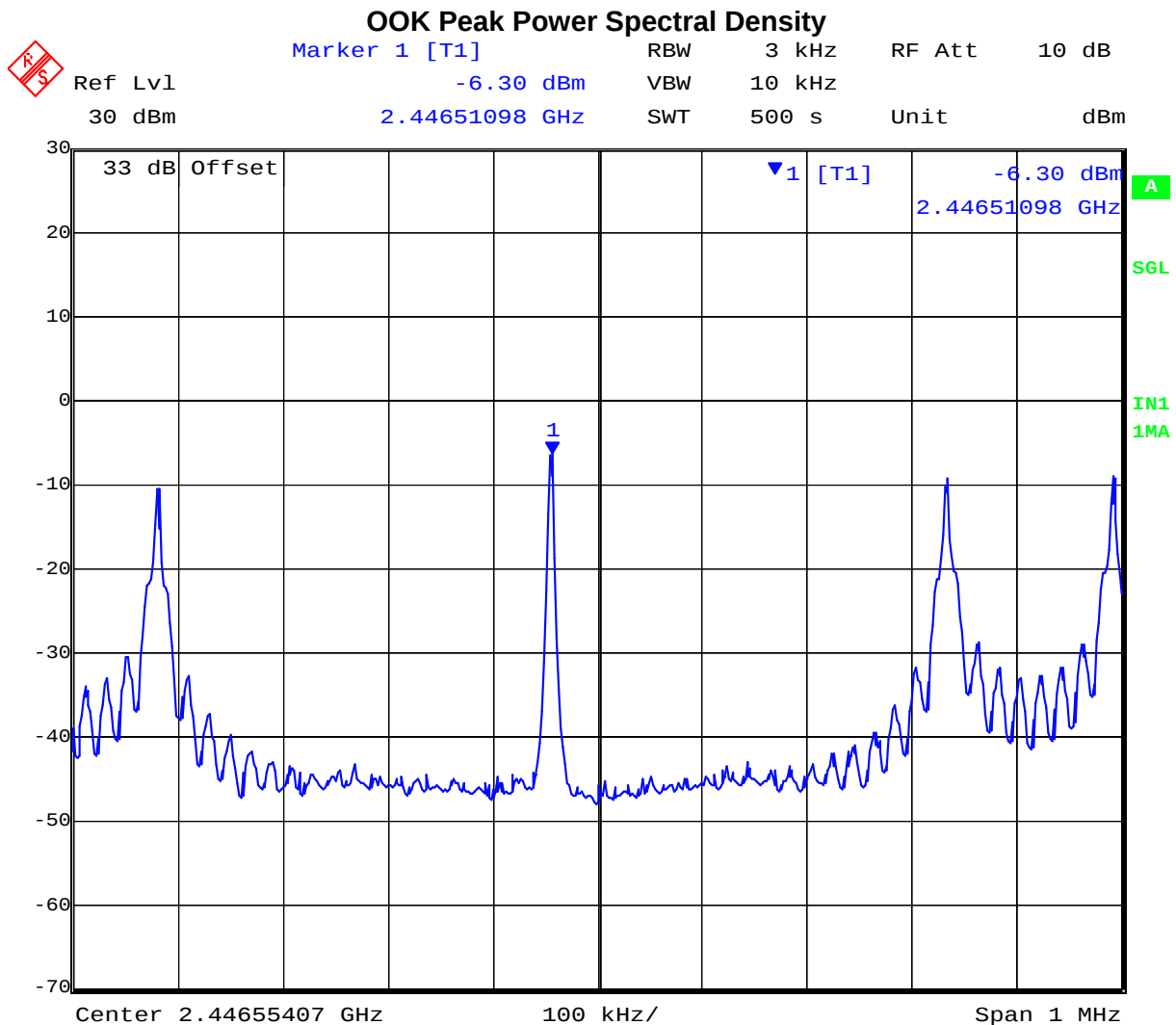
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TABLE OF RESULTS – OOK

Center Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin (dBm)
2,446.519	2446.51098	-6.30	+8	-14.30



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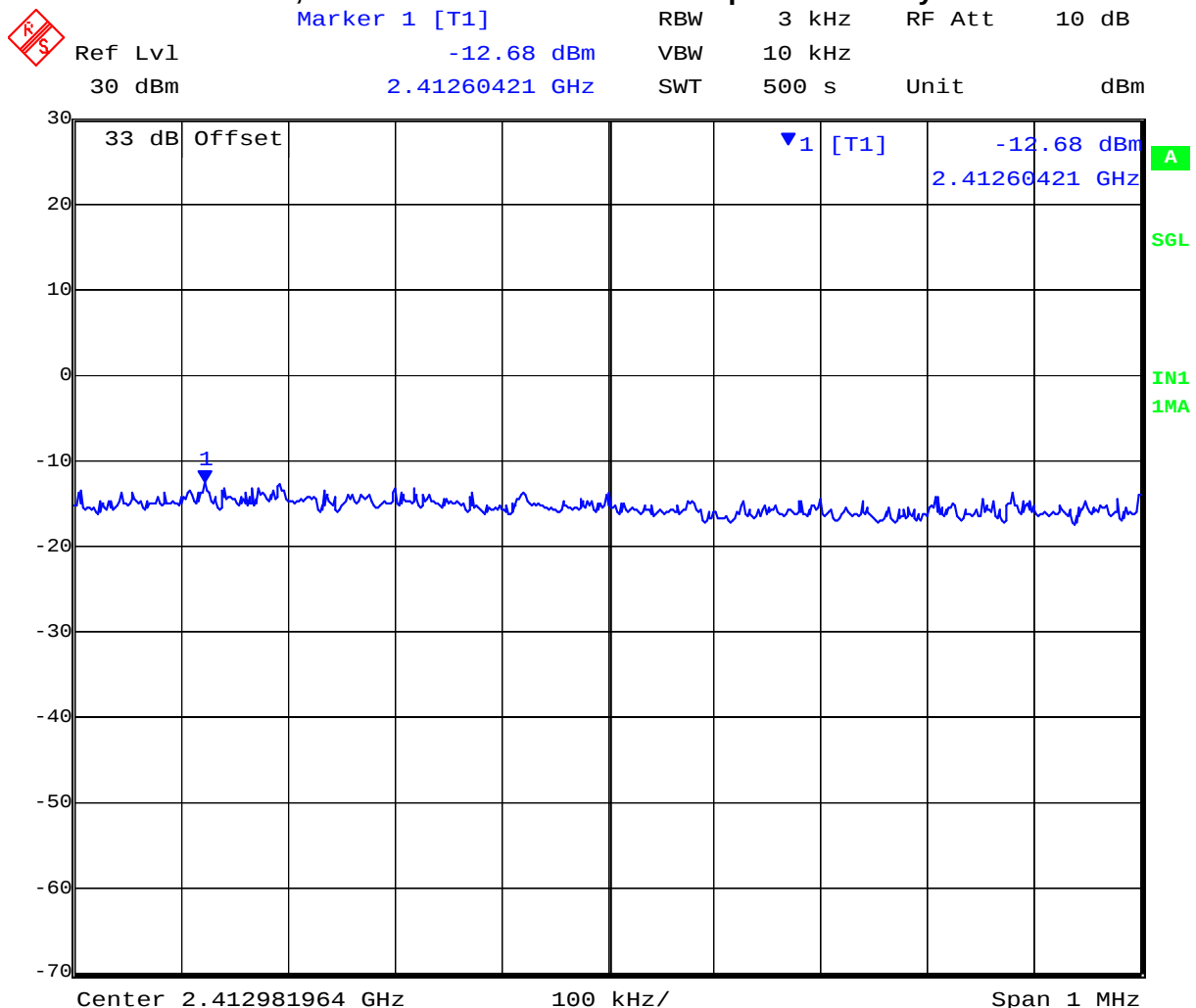


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TABLE OF RESULTS – 802.11b

Center Frequency (MHz)	Peak Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin (dBm)
2,412	2412.60421	-12.68	+8	-20.68
2,437	2435.94689	-12.96	+8	-20.96
2,462	2461.98096	-12.59	+8	-20.59

2,412 MHz 802.11b Peak Power Spectral Density

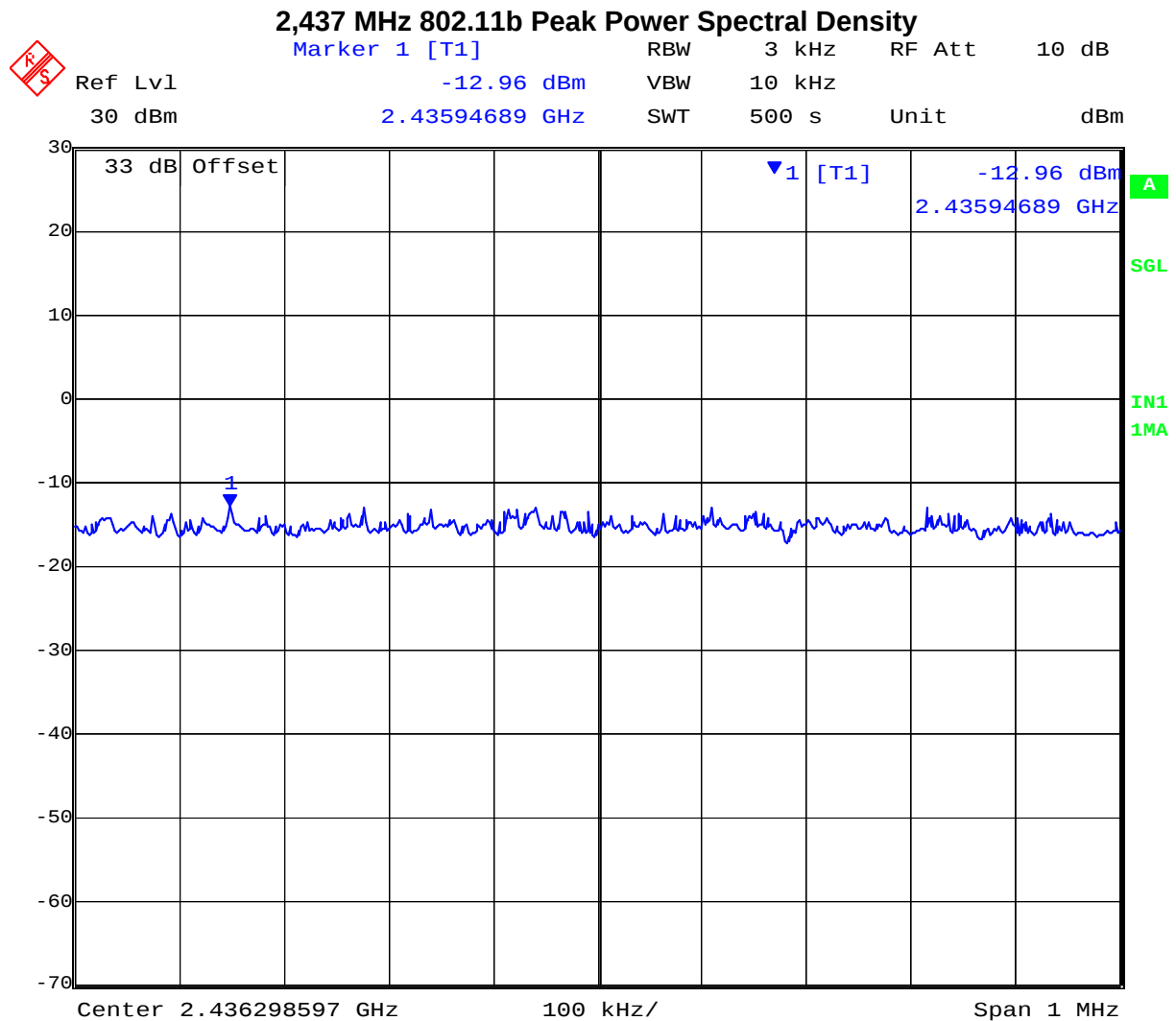


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TABLE OF RESULTS – 802.11b

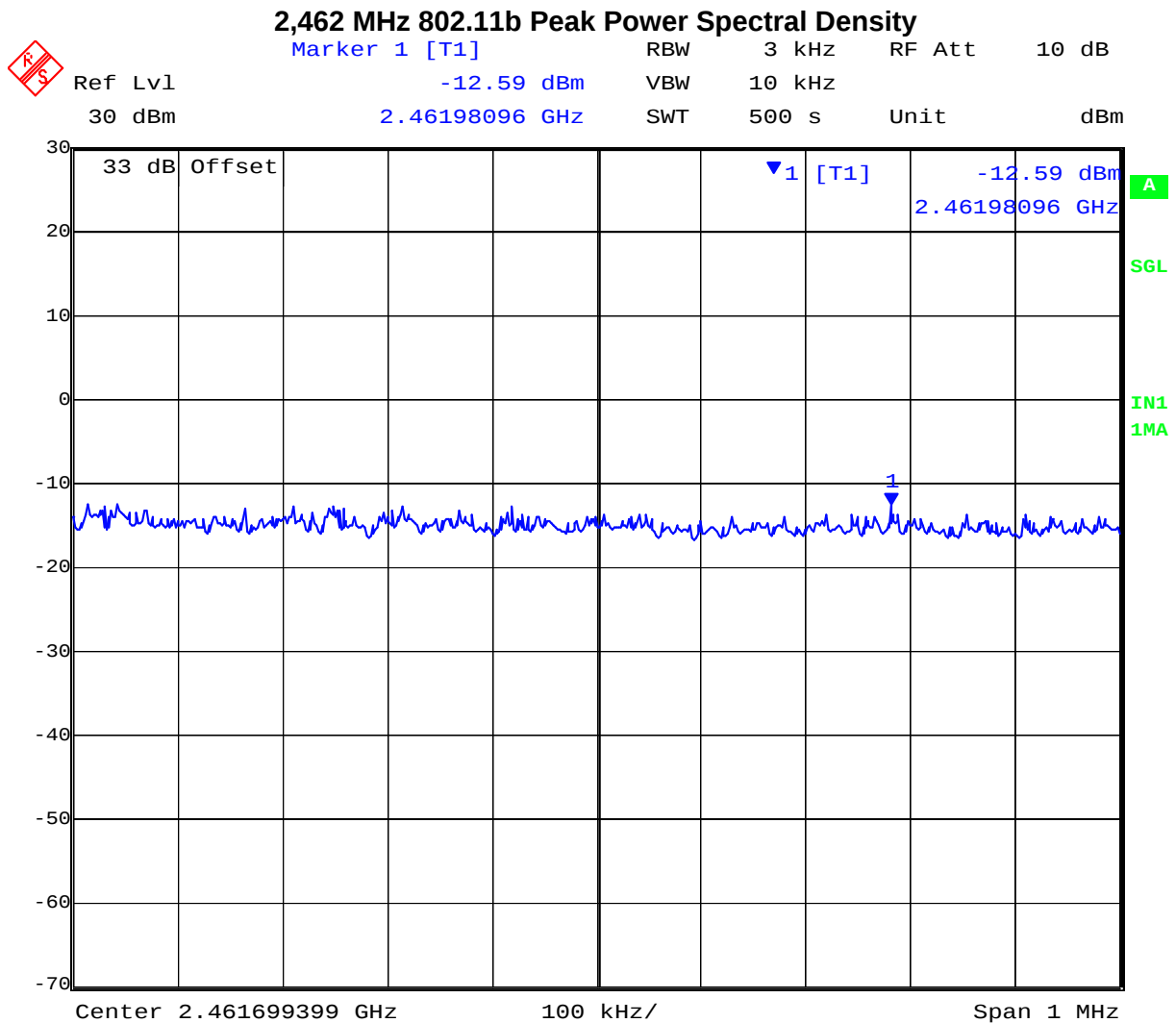


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TABLE OF RESULTS – 802.11b



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Specification

Peak Power Spectral Density Limits

§15.247(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than +8 dBm in any 3 kHz band during any time interval of continuous transmission

RSS-210 §A8.2(2) The transmitter power spectral density (into the antenna) shall not be greater than +8 dBm in any 3 kHz band during any time interval of continuous transmission or over 1.0 second if the transmission exceeds 1.0 second duration.

Laboratory Measurement Uncertainty for Spectral Density

Measurement uncertainty	±1.33 dB
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Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117

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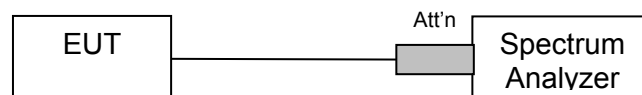
5.1.4. Conducted Spurious Emissions

FCC, Part 15 Subpart C §15.247(d); 15.205; 15.209
Industry Canada RSS-210 §A8.5, §2.2
Industry Canada RSS-Gen 4.7

Test Procedure

Conducted emissions were measured at a limit of 20 dB below the highest in-band spectral density measured with a spectrum analyzer connected to the antenna terminal. Emissions at the band edge were measured and recorded. Measurements were made while EUT was operating in transmit mode of operation at the appropriate center frequency.

Test Measurement Set up



Band-edge measurement test configuration

Measurement Results of Conducted Spurious Emissions

Ambient conditions.

Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

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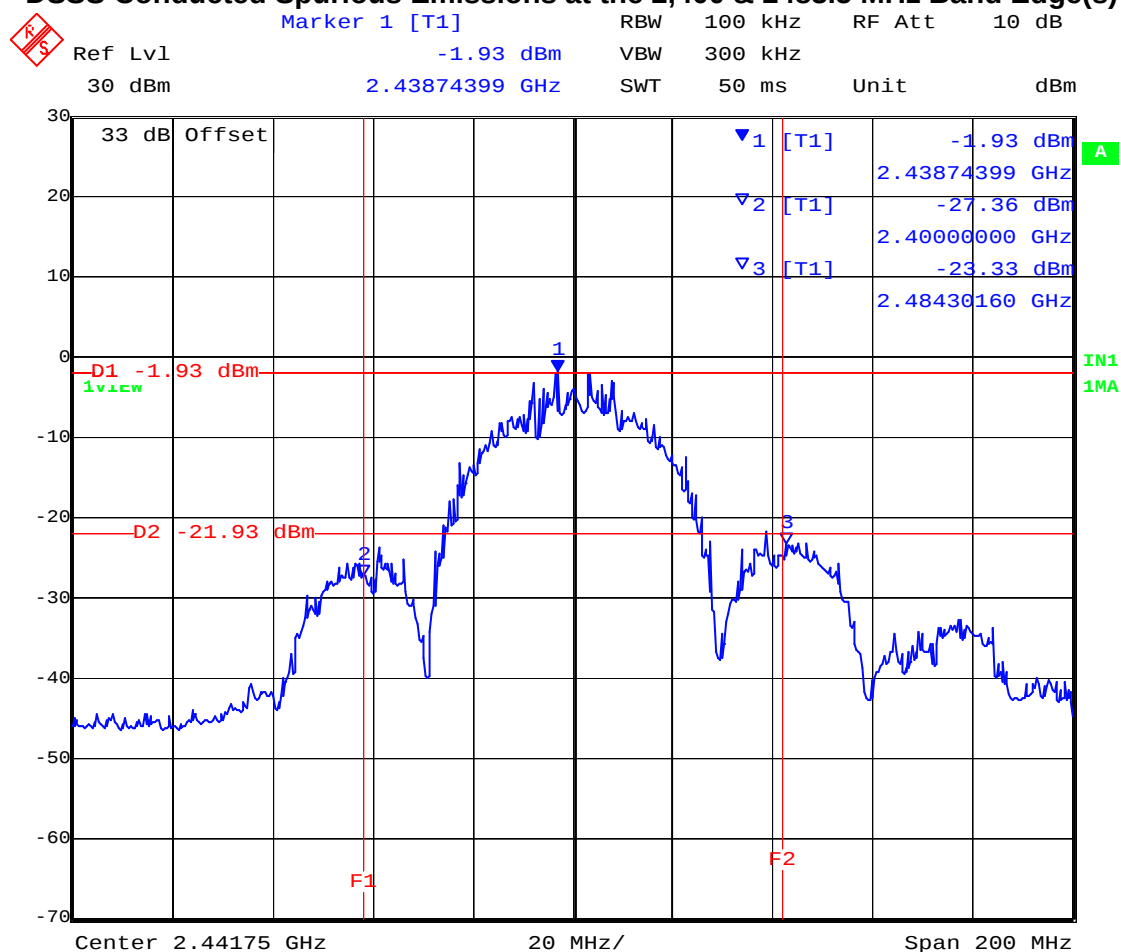
Conducted Band-Edge Results

Measurements were performed with the transmitter tuned to the channel closest to the band-edge being measured. All emissions were maximized during measurement. Limits which were derived from the band-edge measurements provided below are drawn on each plot.

TABLE OF RESULTS – DSSS

Center Frequency (MHz)	Band edge Frequency (MHz)	Limit (20 dB below peak of fundamental) (dBm)	Amplitude @ Band edge (dBm)	Margin (dB)
2,441.75	2,400	-21.93	-27.36	-5.43
2,441.75	2,483.5	-21.93	-23.33	-1.40

DSSS Conducted Spurious Emissions at the 2,400 & 2483.5 MHz Band Edge(s)



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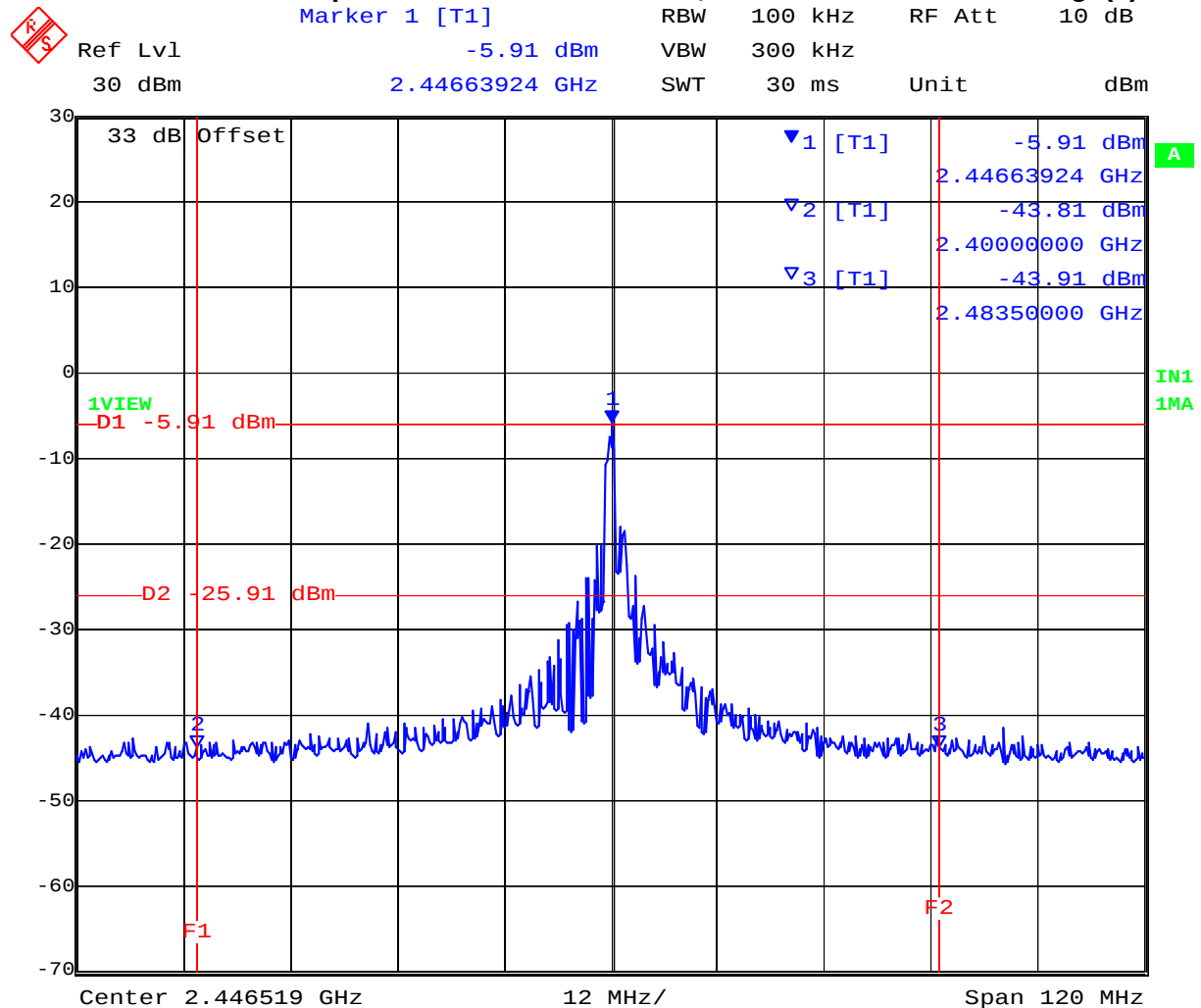


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TABLE OF RESULTS – OOK

Center Frequency (MHz)	Band edge Frequency (MHz)	Limit (20 dB below peak of fundamental) (dBm)	Amplitude @ Band edge (dBm)	Margin (dB)
2,446.519	2,400	-25.91	-43.81	-17.9
2,446.519	2,483.5	-25.91	-43.91	-18.0

OOK Conducted Spurious Emissions at the 2,400 & 2483.5 MHz Band Edge(s)

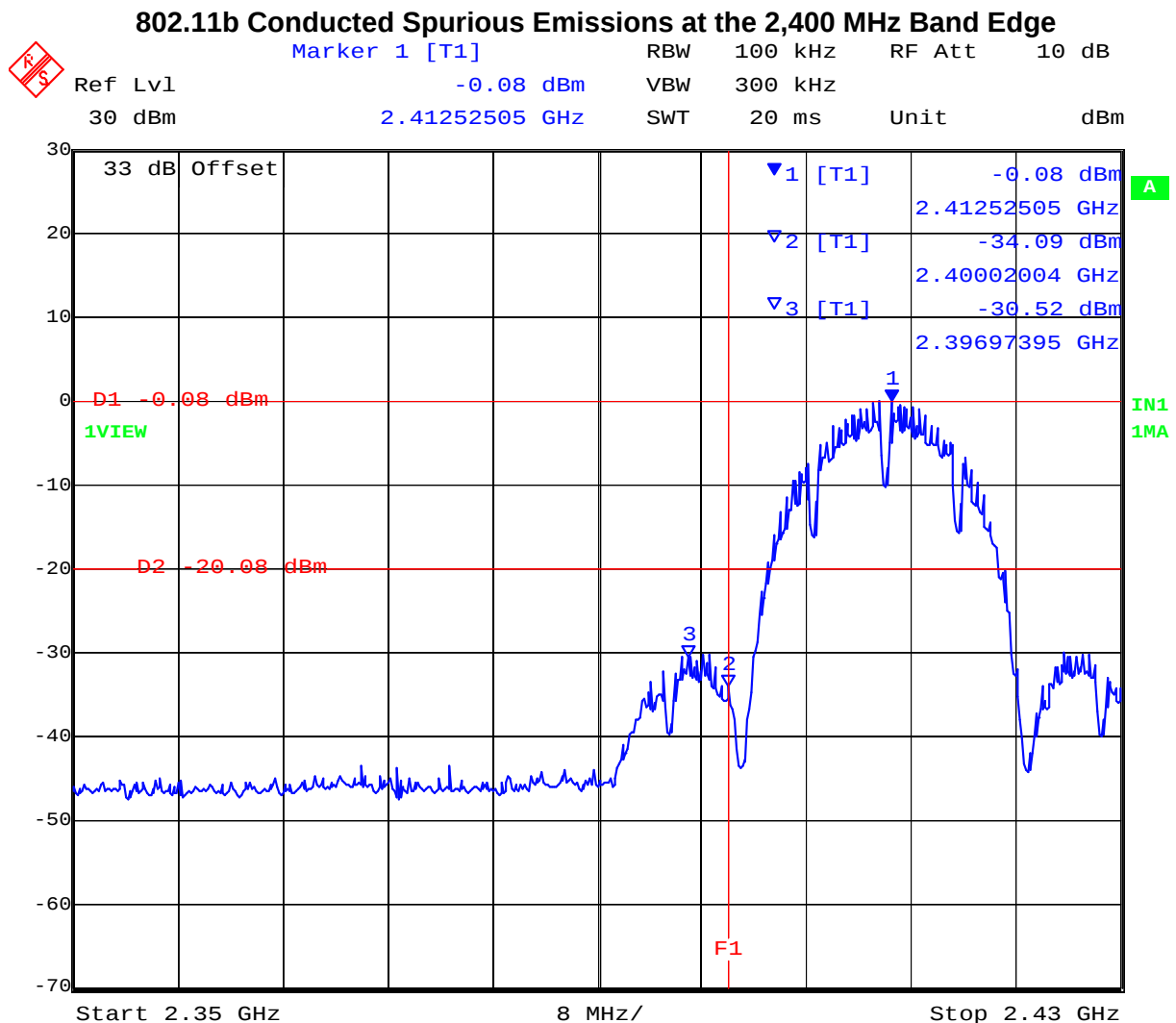


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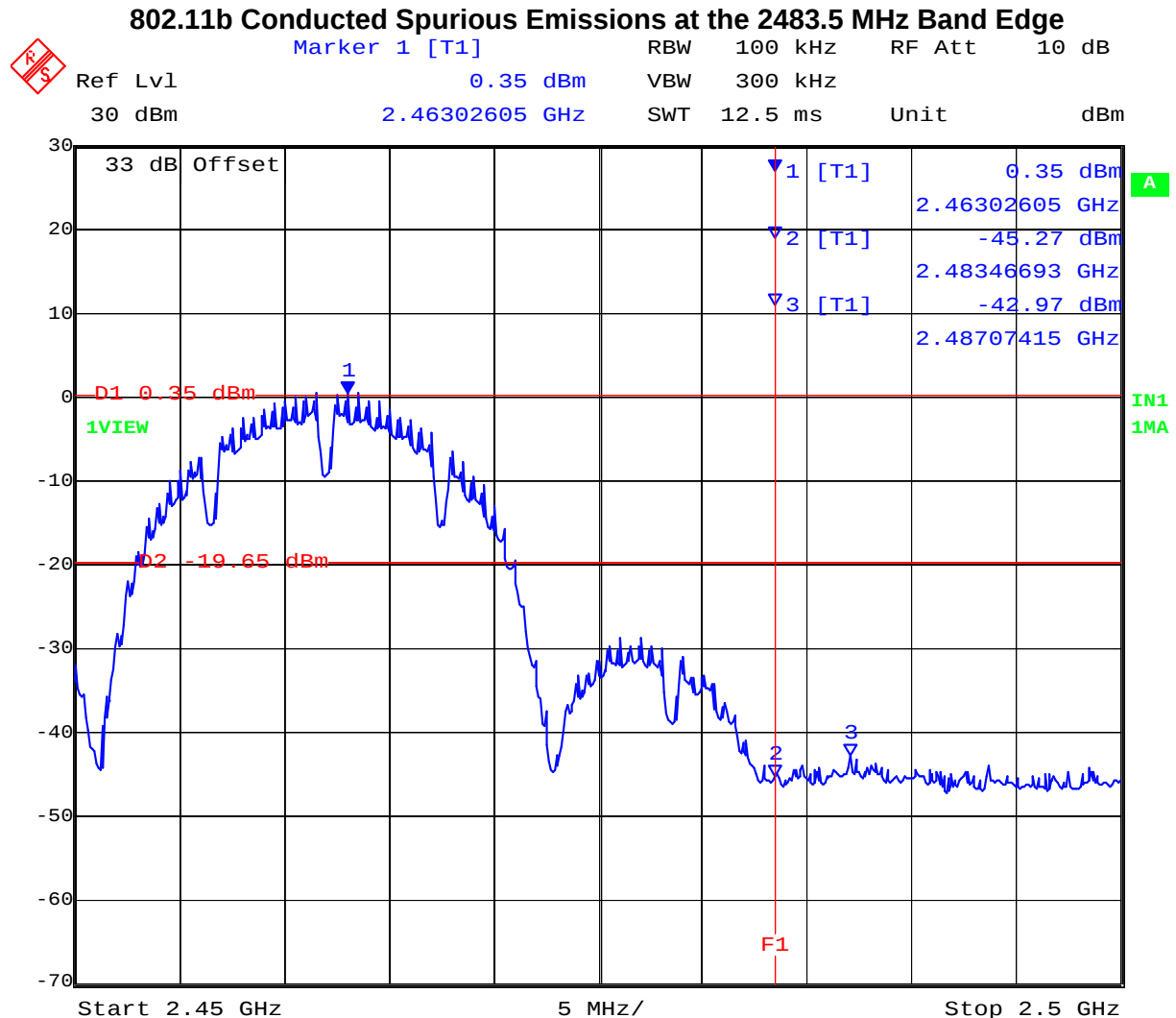
Center Frequency (MHz)	Band edge Frequency (MHz)	Limit (20 dB below peak of fundamental) (dBm)	Amplitude @ Band edge (dBm)	Margin (dB)
2412	2,400	-20.08	-34.09	-14.01
2462	2,483.5	-19.65	-45.27	-25.62



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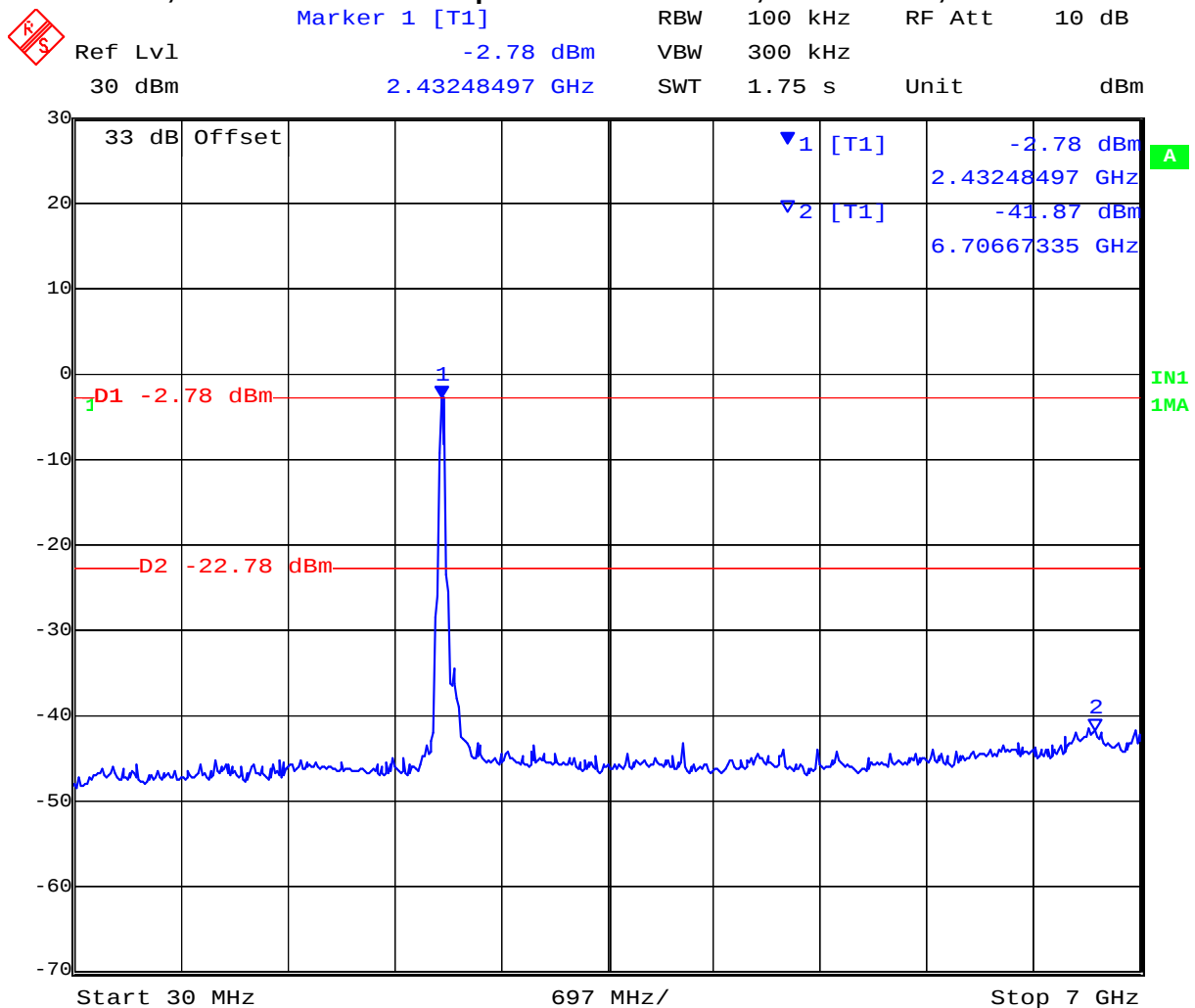
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Spurious Emissions (1-26 GHz)

TABLE OF RESULTS – DSSS

Channel Centre Frequency (MHz)	Start Frequency (MHz)	Stop Frequency (MHz)	Maximum Emission Observed (dBm)	Limit (dBm)	Margin (dB)
2441.75	1,000	7,000	-41.87	-22.78	-19.09
2441.75	7,000	26,000	-33.83	-22.78	-11.05

2,412 MHz Conducted Spurious Emissions 1,000 MHz to 7,000 MHz

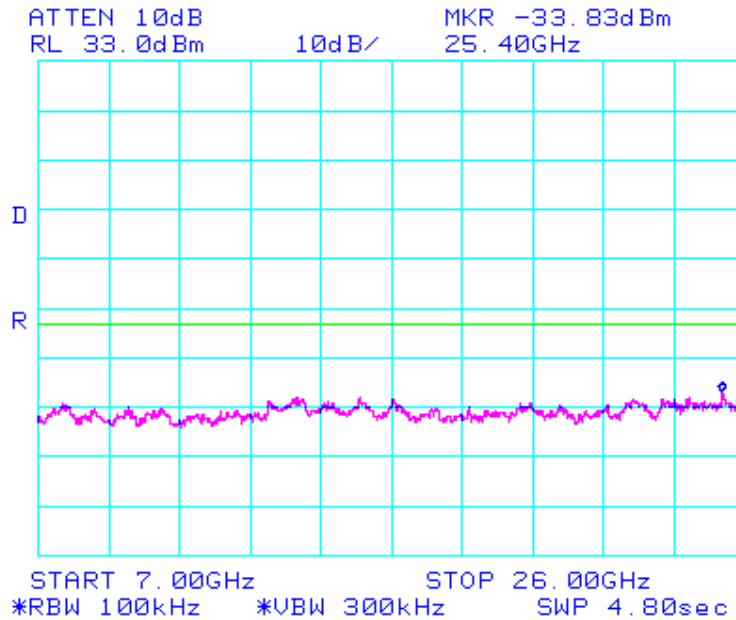


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2,441.75 MHz Conducted Spurious Emissions 7,000 MHz to 26,000 MHz



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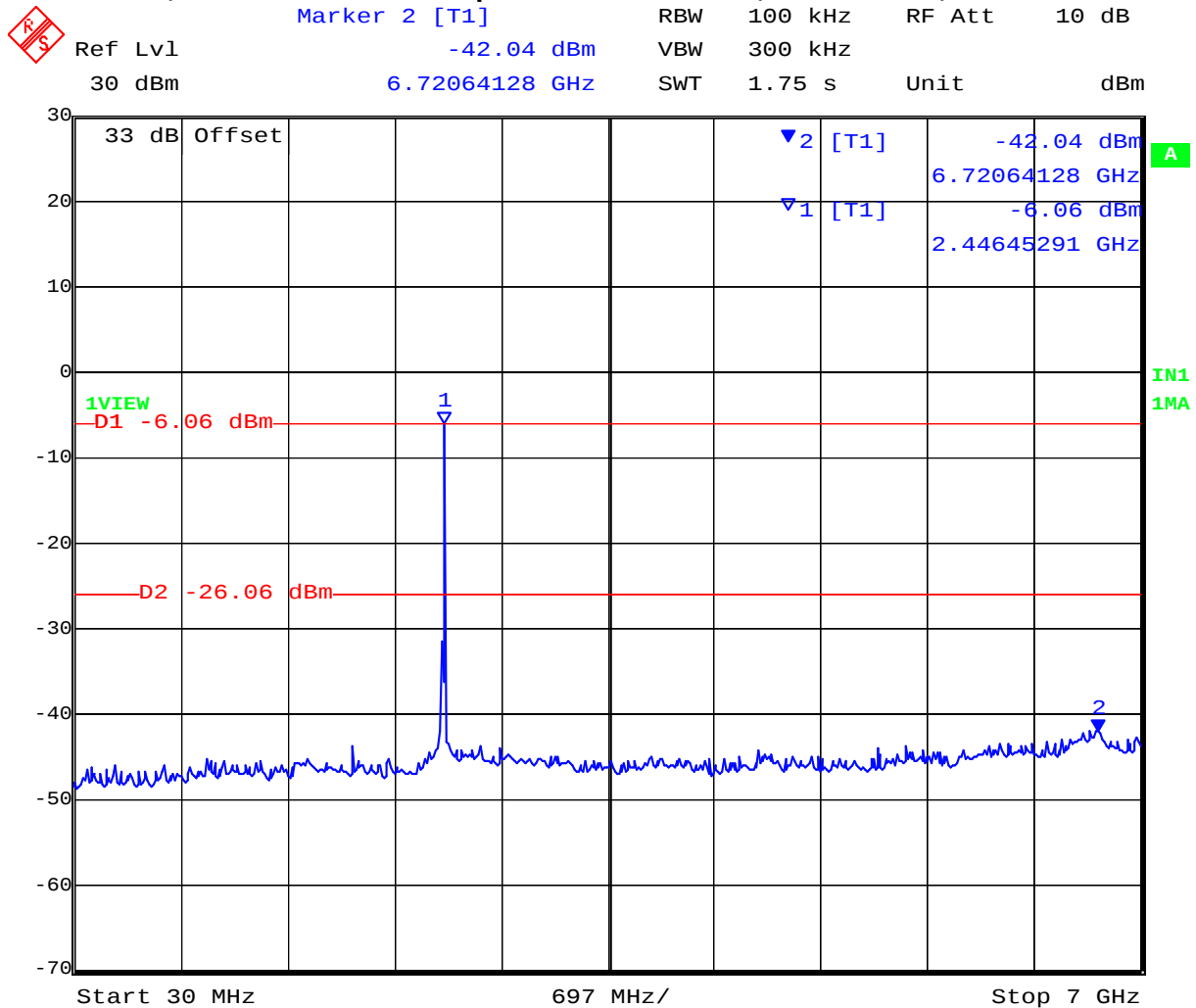


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TABLE OF RESULTS – OOK

Channel Centre Frequency (MHz)	Start Frequency (MHz)	Stop Frequency (MHz)	Maximum Emission Observed (dBm)	Limit (dBm)	Margin (dB)
2446.519	1,000	7,000	-42.04	-26.06	-15.98
2446.519	7,000	26,000	-33.33	-26.06	-7.27

2,412 MHz Conducted Spurious Emissions 1,000 MHz to 7,000 MHz

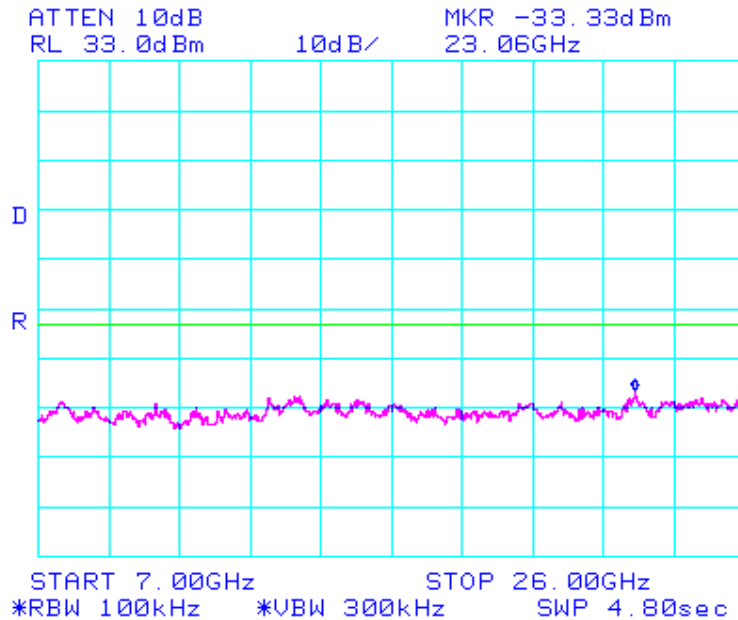


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2,412 MHz Conducted Spurious Emissions 7,000 MHz to 26,000 MHz



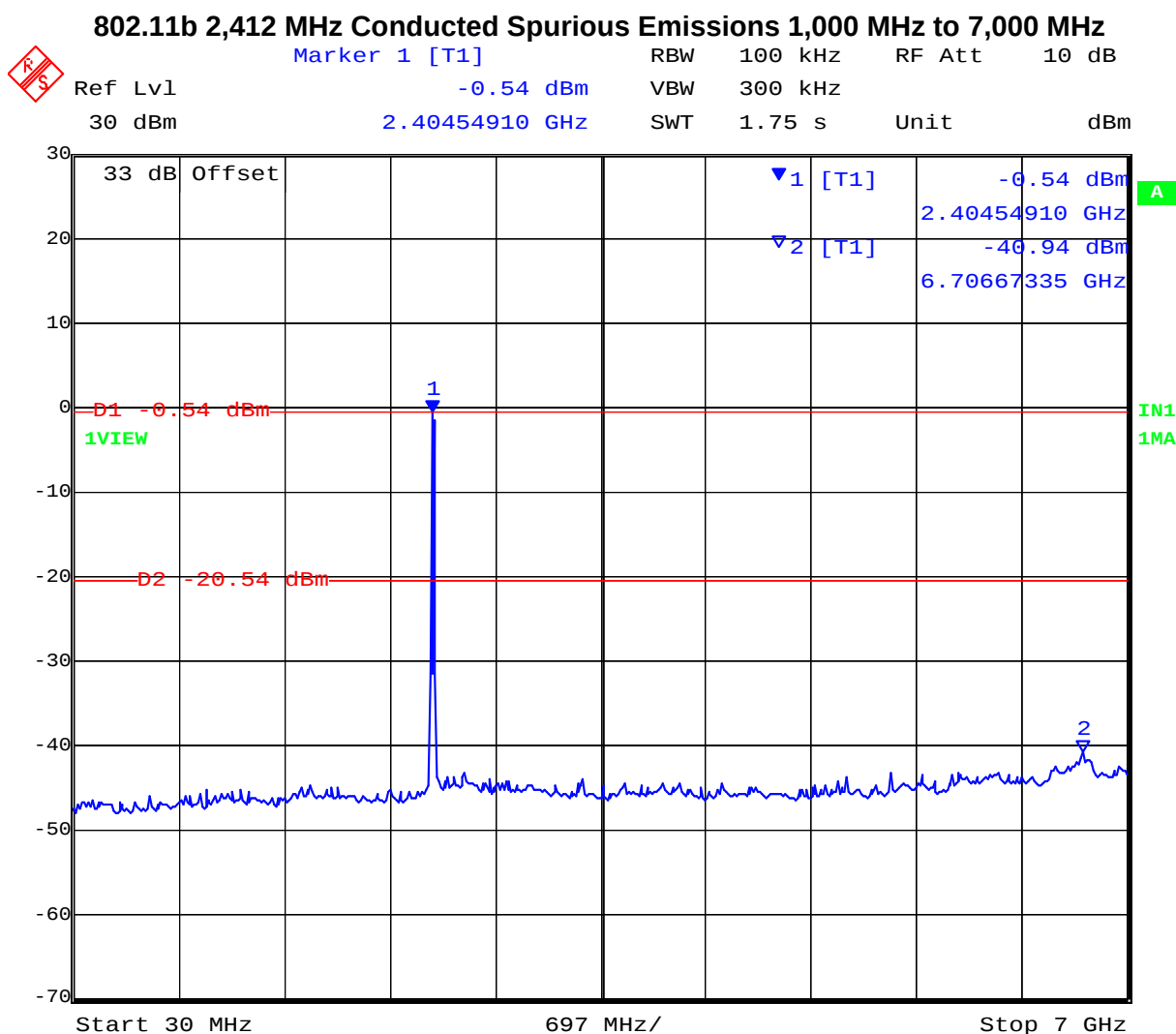
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TABLE OF RESULTS – 802.11b

Channel Centre Frequency (MHz)	Start Frequency (MHz)	Stop Frequency (MHz)	Maximum Emission Observed (dBm)	Limit (dBm)	Margin (dB)
2,412	1,000	7,000	-40.94	-20.54	-20.40
2,412	7,000	26,000	-34.67	-20.54	-14.13

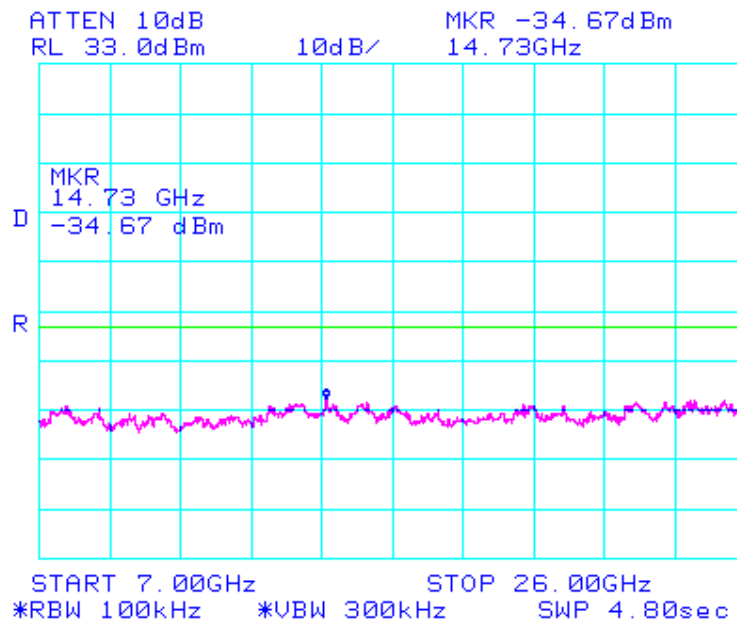


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802.11b 2,412 MHz Conducted Spurious Emissions 7,000 MHz to 26,000 MHz



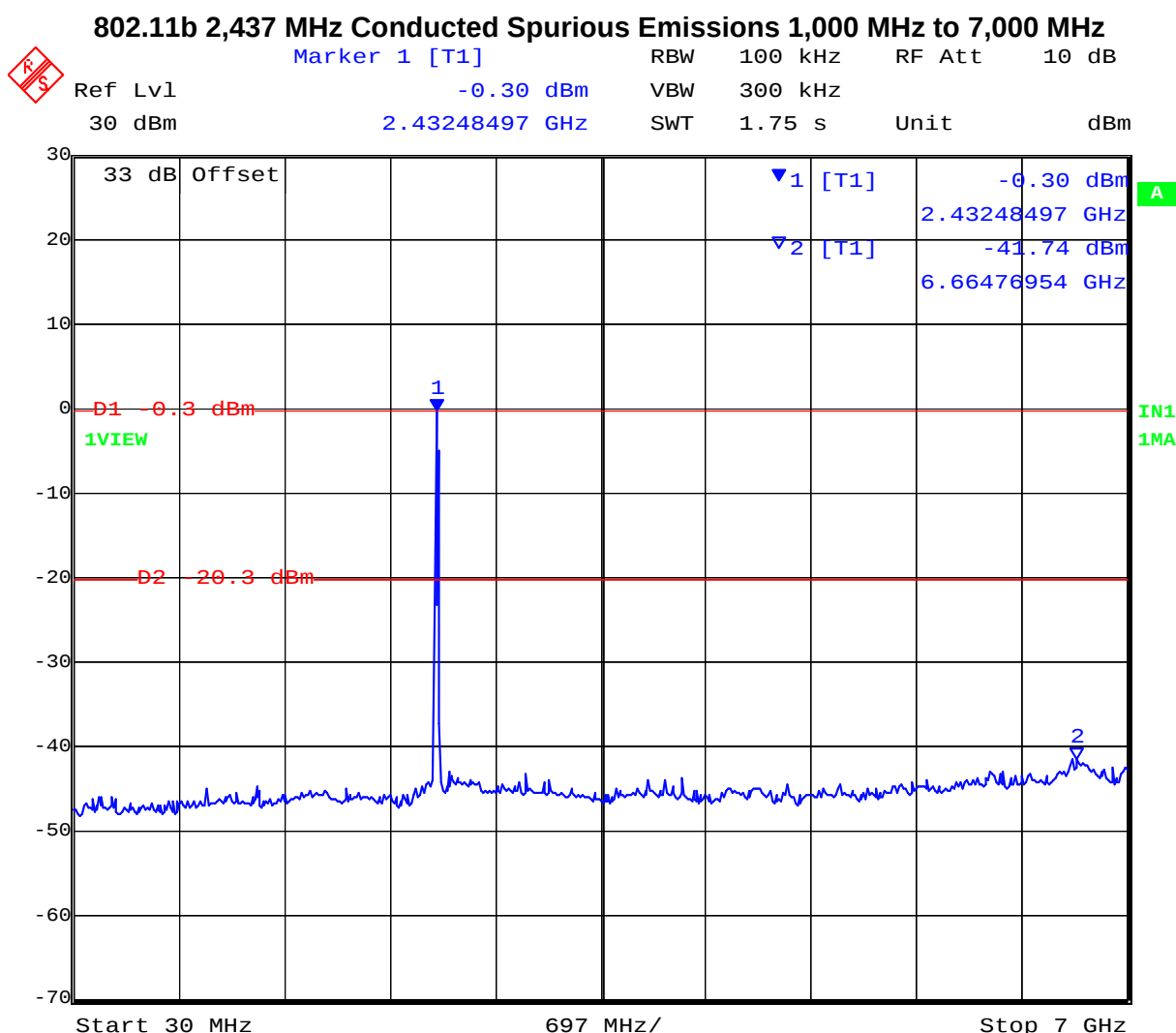
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TABLE OF RESULTS – 802.11b

Channel Centre Frequency	Start Frequency (MHz)	Stop Frequency (MHz)	Maximum Emission Observed (dBm)	Limit (dBm)	Margin (dB)
2,437	1,000	7,000	-41.74	-20.3	-21.44
2,437	7,000	26,000	-35.00	-20.3	-14.70

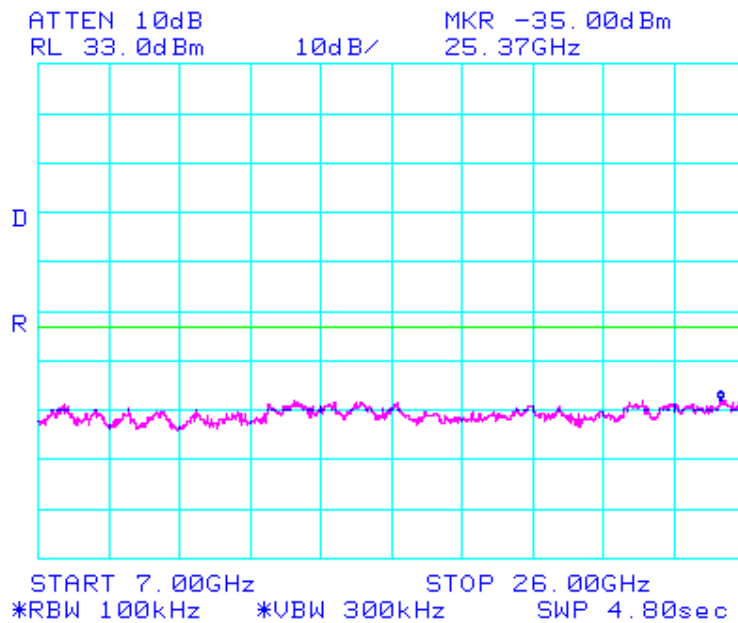


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802.11b 2,437 MHz Conducted Spurious Emissions 7,000 MHz to 26,000 MHz



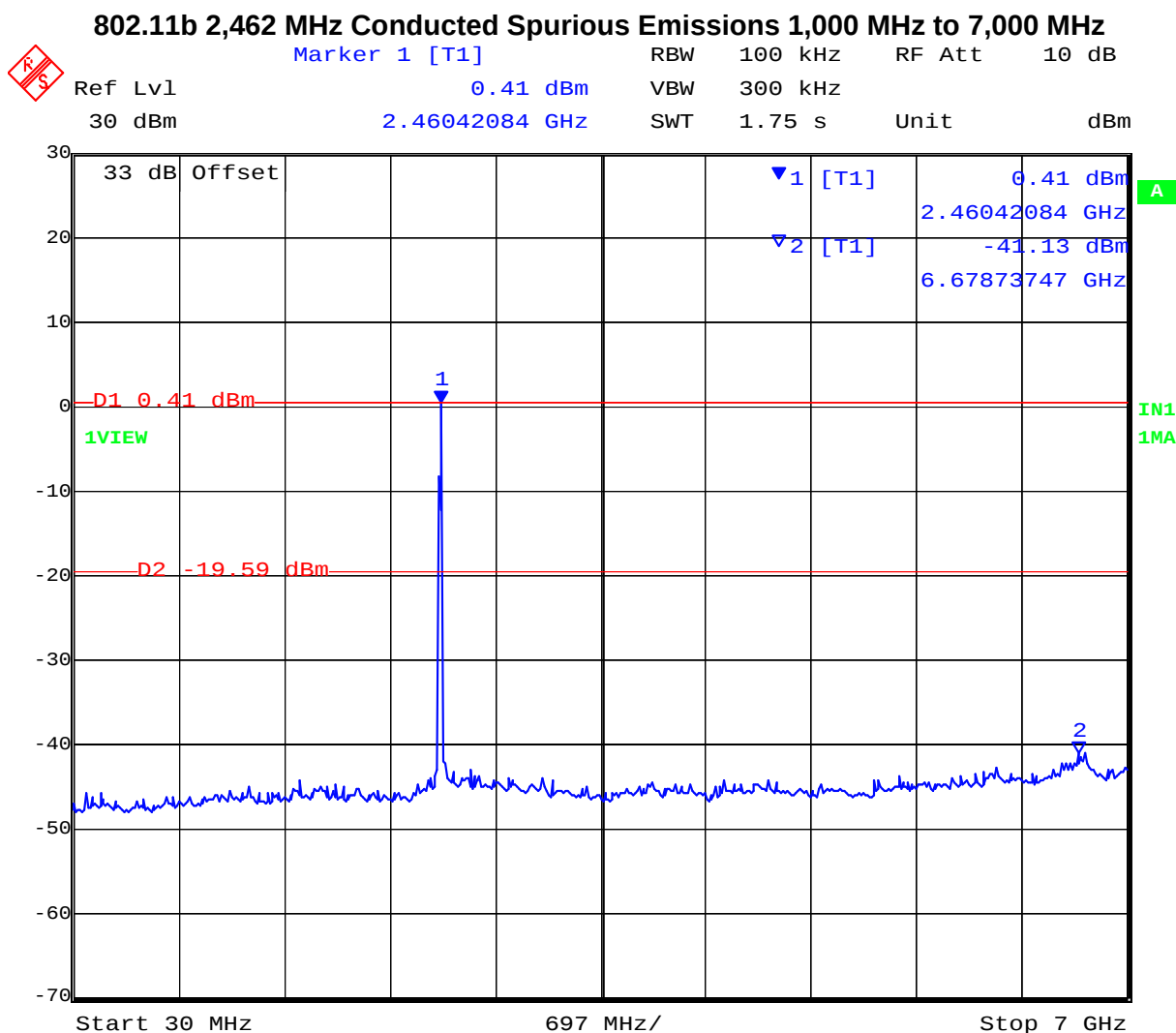
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TABLE OF RESULTS – 802.11b

Channel Centre Frequency	Start Frequency (MHz)	Stop Frequency (MHz)	Maximum Emission Observed (dBm)	Limit (dBm)	Margin (dB)
2,462	1,000	7,000	-41.13	-19.59	-21.54
2,462	7,000	26,000	-34.33	-19.59	-14.79

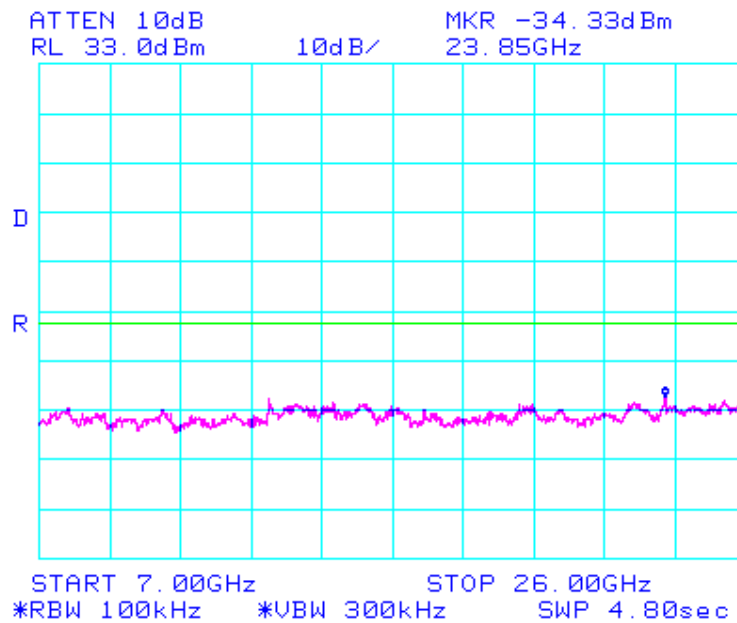


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802.11b 2,462 MHz Conducted Spurious Emissions 7,000 MHz to 26,000 MHz



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Specification

Limits Band-Edge

Lower Limit Band-edge	Upper Limit Band-edge	Limit below highest level of desired power
2,400 MHz	2,483.5 MHz	≥ 20 dB

§15.247(d) and RSS-210 §A8.5 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 radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

§15.247(d)

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 this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified §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(a)).

RSS-210 §A8.5 If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Tables 2 and 3 is not required. In addition, radiated emissions which fall in the restricted bands of Table 1 must also comply with the radiated emission limits specified in Tables 2 and 3.

RSS-Gen §4.7

The search for unwanted emissions shall be from the lowest frequency internally generated or used in the device (local oscillator, intermediate of carrier frequency), or from 30 MHz , whichever is the lowest frequency, to the 5th harmonic of the highest frequency generated without exceeding 40 GHz.

Laboratory Measurement Uncertainty for Conducted Spurious Emissions

Measurement uncertainty	±2.37 dB
-------------------------	----------

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-05 'Measurement of Spurious Emissions'	0088, 0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117.

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5.1.5. Radiated Emissions

5.1.5.1. Transmitter Radiated Spurious Emissions (above 1 GHz)

FCC, Part 15 Subpart C §15.247(d) 15.205; 15.209

Industry Canada RSS-210 §A8.5, §2.2, §2.6

Industry Canada RSS-Gen §4.7

Test Procedure

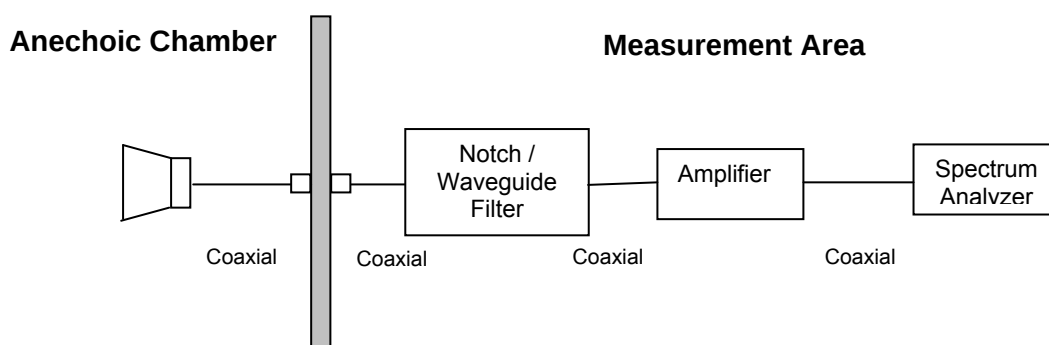
Radiated emissions above 1 GHz are measured in the anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarities. The emissions are recorded and maximized as a function of azimuth by rotation through 360° with a spectrum analyzer in peak hold mode. Depending on the frequency band spanned a notch filter and waveguide filter was used to remove the fundamental frequency. The highest emissions relative to the limit are listed for each frequency spanned.

All measurements on any frequency or frequencies over 1 MHz are based on the use of measurement instrumentation employing an average detector function. All measurements above 1 GHz were performed using a minimum resolution bandwidth of 1 MHz.

The product was initially tested to find worst case orientation for the maximization of spurious emissions. Worst case orientation was used for all emission testing.

Due to the battery drain as a result of the 100% duty cycle transmission the internal battery was disconnected and an external power source (3.6 Vdc) was used.

Test Measurement Set up



Measurement set up for Radiated Emission Test



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Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

$$FS = R + AF + CORR - FO$$

where: FS = Field Strength

R = Measured Spectrum analyzer Input Amplitude

AF = Antenna Factor

CORR = Correction Factor = CL – AG + NFL

CL = Cable Loss

AG = Amplifier Gain

FO = Distance Falloff Factor

NFL = Notch Filter Loss or Waveguide Loss

For example:

Given receiver input reading of 51.5 dB μ V; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength of the measured emission is:

$$FS = 51.5 + 8.5 + 1.3 - 26.0 + 1 = 36.3 \text{ dB}\mu\text{V/m}$$

Conversion between dB μ V/m (or dB μ V) and μ V/m (or μ V) are done as:

$$\text{Level (dB}\mu\text{V/m)} = 20 * \text{Log (level (}\mu\text{V/m))}$$

$$40 \text{ dB}\mu\text{V/m} = 100 \mu\text{V/m}$$

$$48 \text{ dB}\mu\text{V/m} = 250 \mu\text{V/m}$$

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Radiated Spurious Emissions above 1 GHz

Ambient conditions.

Temperature: 17 to 23°C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

Measurements performed with EUT set for 100% Duty Cycle

Manufacturer's Declared Operational Duty Cycle: 2.55%

DSSS OPERATIONAL MODE

DSSS Configuration Peak Emissions & Band Edge

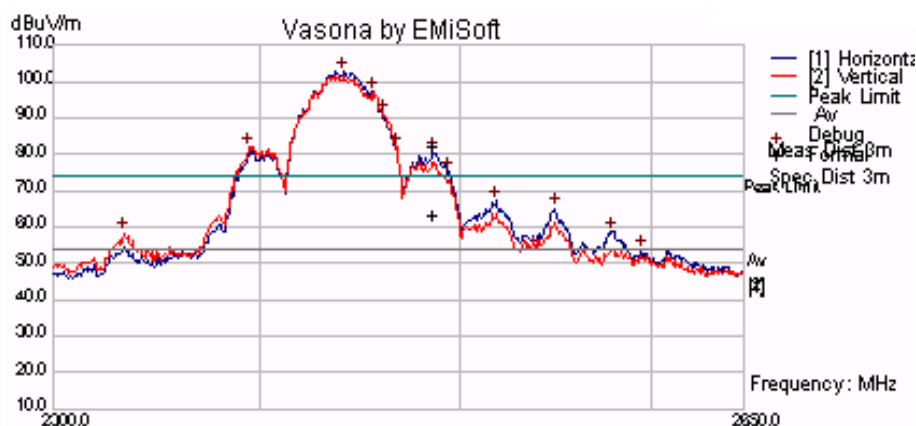


TABLE OF RESULTS – DSSS Configuration

Emission Type	Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	AF (dB)	Peak Level (dBuV/m)	Ave.rage Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
Peak.	2441.683	69.35	2.97	30.53	102.85	--	--	--
Band Edge ¹	2486.647	45.74	2.99	30.66	79.39	47.52	54	-6.48
Band Edge ¹	2394.689	44.68	2.95	30.39	78.02	46.15	54	-7.85

¹ Band edge measurement: Per FCC's Digital Transmission Systems, Measurements and Procedures Public Notice DA 00-705 Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. Average value of emission is calculated by the following equation;

Peak value - 20 Log (duty cycle)

Operational duty cycle: 2.55% (ON 2.55 mS, OFF 100 mS) where 100mS is the measurement period

Peak value - 20 Log (0.0255) = -31.87 dB

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DSSS Configuration Spurious Emissions >1GHz

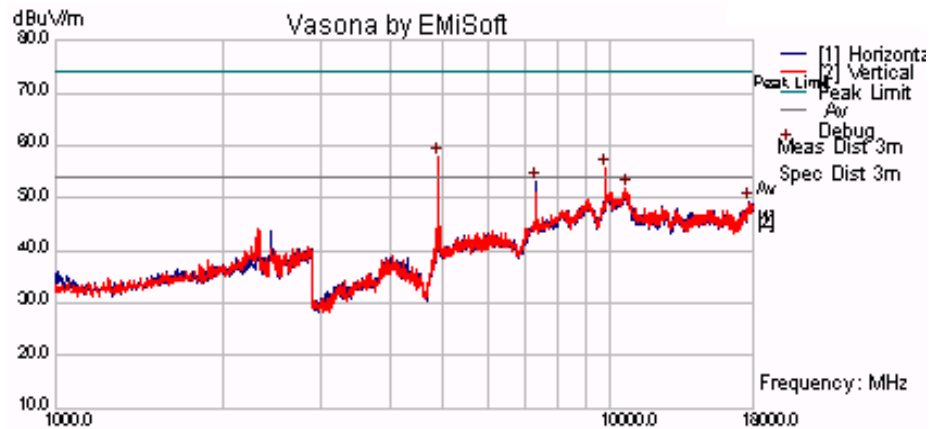


TABLE OF RESULTS – DSSS Configuration

Freq. (MHz)	Pol. (H/V)	Corrected Peak Field Strength (dB μ V/m)	Corrected Average Field Strength (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
¹ 4889.167	H	57.83	25.96	54	-28.04
² 9768.333	V	55.60	--	82.85	-27.25
¹ 7330.00	H	53.12	21.25	54	-32.75
¹ 10631.67	V	51.78	19.91	54	-34.09

¹Restricted band emissions, average value calculation: Peak value - 20 Log (duty cycle)

Peak value - 20 Log (0.0255) = -31.87 dB

²Harmonic of the fundamental, non-restricted band emissions, limit 20 dB below fundamental peak level.



OOK OPERATIONAL MODE

Measurements performed with EUT set for 100% Duty Cycle

Manufacturer's Declared Operational Duty Cycle: 13%

OOK Configuration Peak Emissions & Band Edge

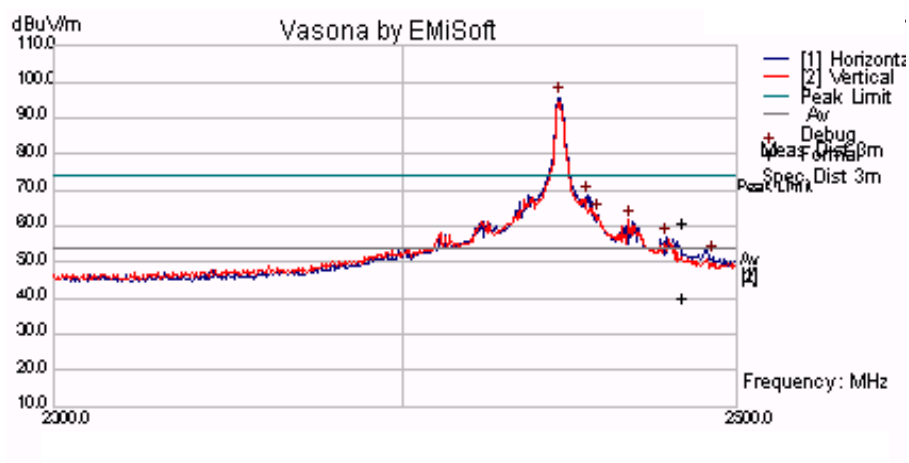


TABLE OF RESULTS – OOK Configuration

Emission Type	Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	AF (dB)	Peak Level (dBuV/m)	Average Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
Peak.	2446.691	62.28	2.98	30.55	95.8	--	--	--
Band Edge ¹	2390.00	24.24	2.95	30.38	57.57	39.85	54	-14.15
Band Edge ¹	2483.50	24.1	2.99	30.65	57.75	40.03	54	-13.97

¹ Band edge measurement: Per FCC's Digital Transmission Systems, Measurements and Procedures Public Notice DA 00-705 Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. Average value of emission is calculated by the following equation;

Peak value - 20 Log (duty cycle)

Operational duty cycle: 13.0% (ON 13 mS, OFF 100 mS)

Peak value - 20 Log (0.13) = -17.72 dB



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OOK Configuration Spurious Emissions >1GHz

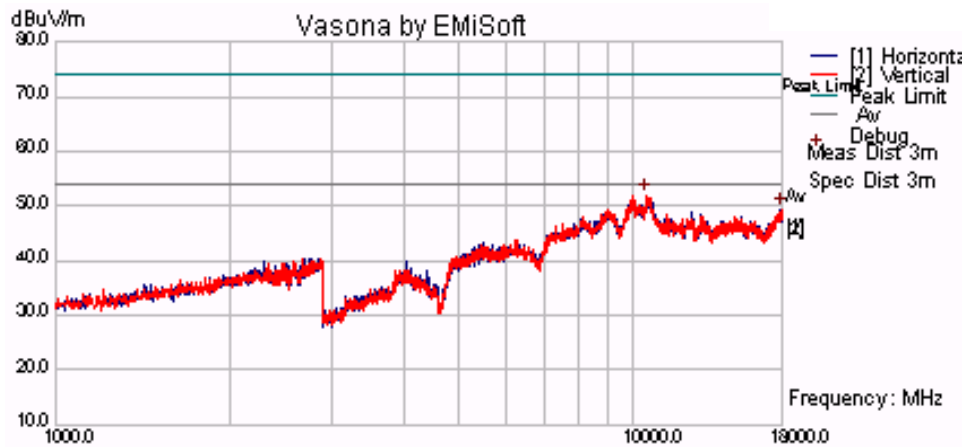


TABLE OF RESULTS – OOK Configuration

Freq. (MHz)	Pol. (H/V)	Corrected Peak Field Strength (dB μ V/m)	Corrected Average Field Strength (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)

No emissions found within 6 dB of the limit

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802.11b OPERATIONAL MODE

Measurements performed with EUT set for 100% Duty Cycle

Manufacturer's Declared Operational Duty Cycle: 3.6%

Channel 2412MHz

802.11b, 2412 MHz Configuration Peak Emissions & Band Edge

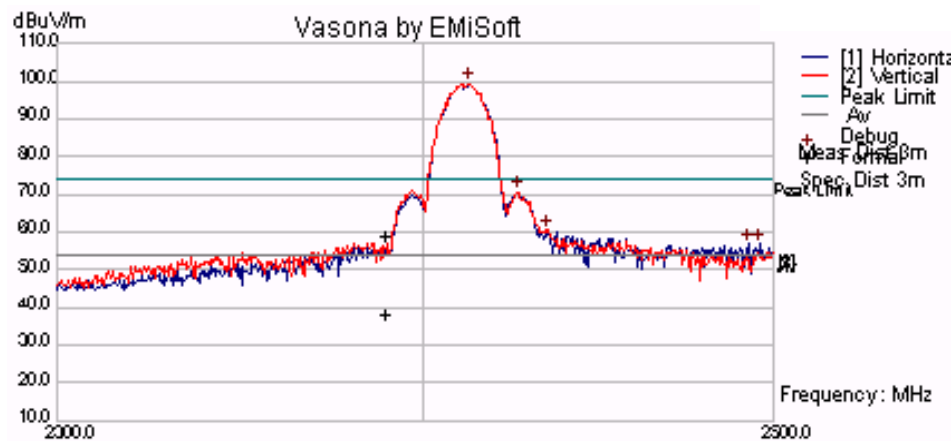


TABLE OF RESULTS – 802.11b Configuration

Emission Type	Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	AF (dB)	Peak Level (dBuV/m)	Average Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
Peak.	2413.026	65.97	2.96	30.45	99.37	--	--	--
Band Edge ¹	2390.00	22.76	2.95	30.38	56.09	27.22	54	-26.78

¹ Band edge measurement: Per FCC's Digital Transmission Systems, Measurements and Procedures Public Notice DA 00-705 Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. Average value of emission is calculated by the following equation;

Peak value - 20 Log (duty cycle)

Operational duty cycle: 3.6% (ON 3.6 mS, OFF 100 mS)

Peak value - 20 Log (0.036) = -28.87 dB

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802.11b, 2412 MHz Configuration Spurious Emissions >1GHz

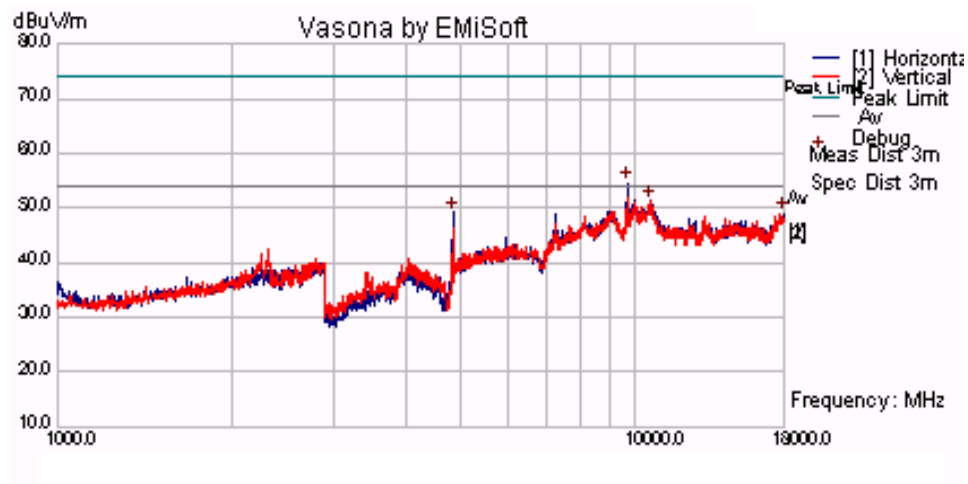


TABLE OF RESULTS – 802.11b Configuration

Freq. (MHz)	Pol. (H/V)	Corrected Peak Field Strength (dB μ V/m)	Corrected Average Field Strength (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
² 9651.667	H	54.51	--	79.37	-24.86

²Harmonic of the fundamental, non-restricted band emission, limit 20 dB below fundamental peak level.



802.11b OPERATIONAL MODE

Measurements performed with EUT set for 100% Duty Cycle

Channel 2437MHz

802.11b, 2437 MHz Configuration Peak Emissions

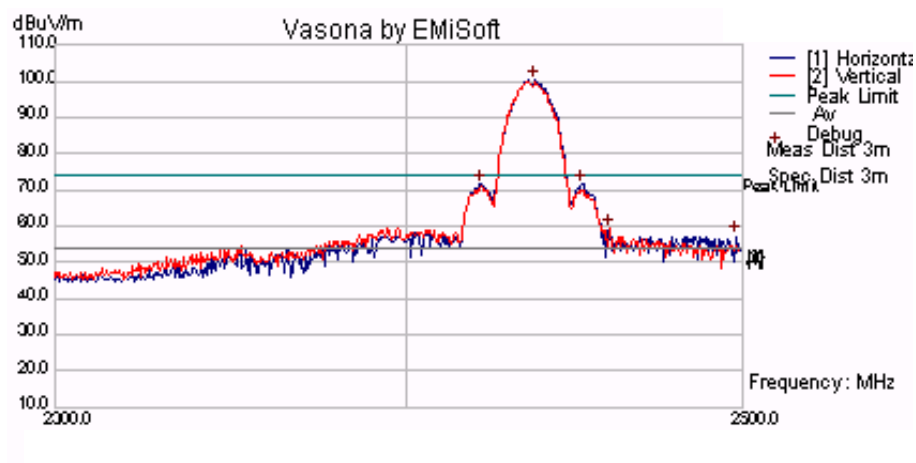


TABLE OF RESULTS – 802.11b Configuration

Emission Type	Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	AF (dB)	Peak Level (dBuV/m)	Average Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
Peak.	2437.876	66.86	2.97	30.52	100.35	--	--	--

802.11b, 2437 MHz Configuration Spurious Emissions

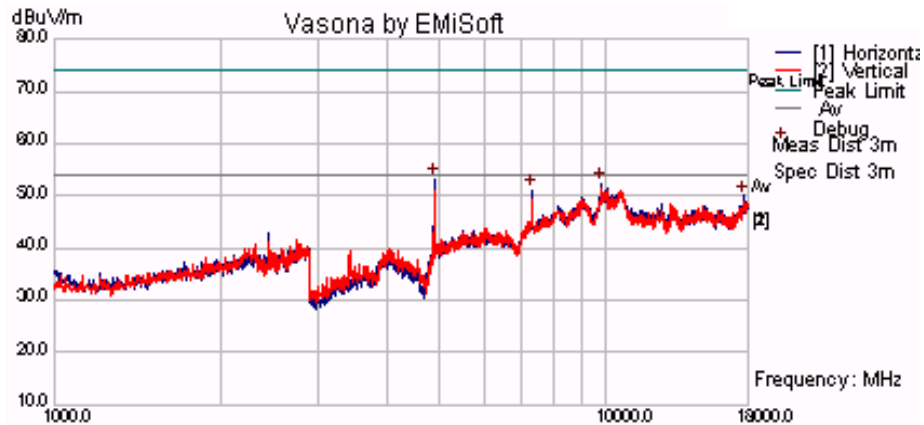


TABLE OF RESULTS – 802.11b Configuration

Freq. (MHz)	Pol. (H/V)	Corrected Peak Field Strength (dBμV/m)	Corrected Average Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)

No spurious emissions were found above the limit

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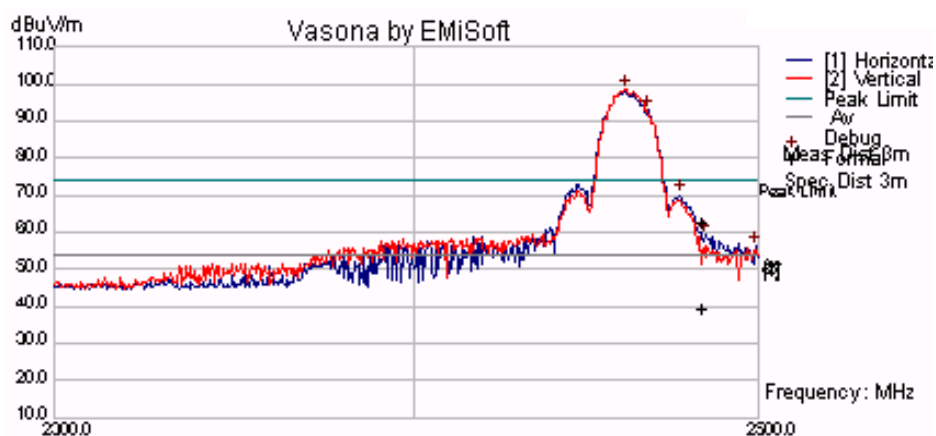
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802.11b OPERATIONAL MODE

Measurements performed with EUT set for 100% Duty Cycle

Channel 2462 MHz

802.11b, 2462 MHz Configuration Peak Emissions & Band Edge



Emission Type	Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	AF (dB)	Peak Level (dBuV/m)	Average Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
Peak.	2461.122	65.02	2.98	30.59	98.59	--	--	--
Band Edge ¹	2483.50	25.81	2.99	30.65	59.45	30.58	54	-23.42

¹ Band edge measurement: Per FCC's Digital Transmission Systems, Measurements and Procedures Public Notice DA 00-705 Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. Average value of emission is calculated by the following equation;

Peak value - 20 Log (duty cycle)

Operational duty cycle: 3.6% (ON 3.6 mS, OFF 100 mS)

Peak value - 20 Log (0.036) = -28.87 dB

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802.11b, 2462 MHz Configuration Peak Emissions

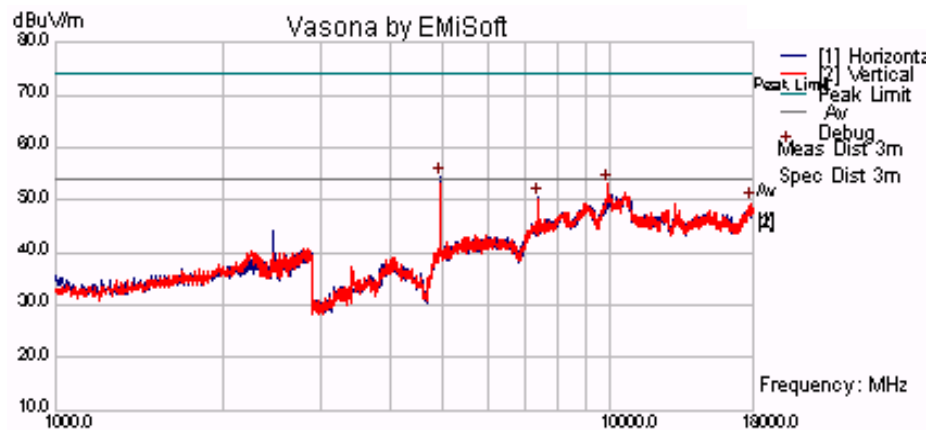


TABLE OF RESULTS – 802.11b Configuration

Freq. (MHz)	Pol. (H/V)	Corrected Peak Field Strength (dBμV/m)	Corrected Average Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
¹ 4925.333	H	54.22	25.35	54	-28.65
² 9850.00	V	53.08	--	78.59	-25.51

¹ Band edge measurement: Per FCC's Digital Transmission Systems, Measurements and Procedures Public Notice DA 00-705 Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems. Average value of emission is calculated by the following equation;

Peak value - 20 Log (duty cycle)

Operational duty cycle: 3.6% (ON 3.6 mS, OFF 100 mS)

Peak value - 20 Log (0.036) = -28.87 dB

²Harmonic of the fundamental, non-restricted band emission, limit 20 dB below fundamental peak level.



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Specification Limits

FCC §15.247(d) and RSS-210 §A8.5 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 radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

FCC §15.247(d)

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 this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified §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(a)).

IC RSS-210 §A8.5 If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Tables 2 and 3 is not required. In addition, radiated emissions which fall in the restricted bands of Table 1 must also comply with the radiated emission limits specified in Tables 2 and 3.

IC RSS-Gen §4.7

The search for unwanted emissions shall be from the lowest frequency internally generated or used in the device (local oscillator, intermediate of carrier frequency), or from 30 MHz , whichever is the lowest frequency, to the 5th harmonic of the highest frequency generated without exceeding 40 GHz.

FCC §15.205 (a) Except as shown in paragraph (d) of 15.205 (a), only spurious emissions are permitted in any of the frequency bands listed.

FCC §15.205 (a) Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

FCC §15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.



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Frequency (MHz)	Field Strength (μ V/m)	Field Strength (dB μ V/m)	Measurement Distance (meters)
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

Laboratory Measurement Uncertainty for Radiated Emissions

Measurement uncertainty	+5.6/ -4.5 dB
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Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions'	0088, 0158, 0134, 0304, 0311, 0315, 0310, 0312

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5.1.5.2. Receiver Radiated Spurious Emissions (above 1 GHz)

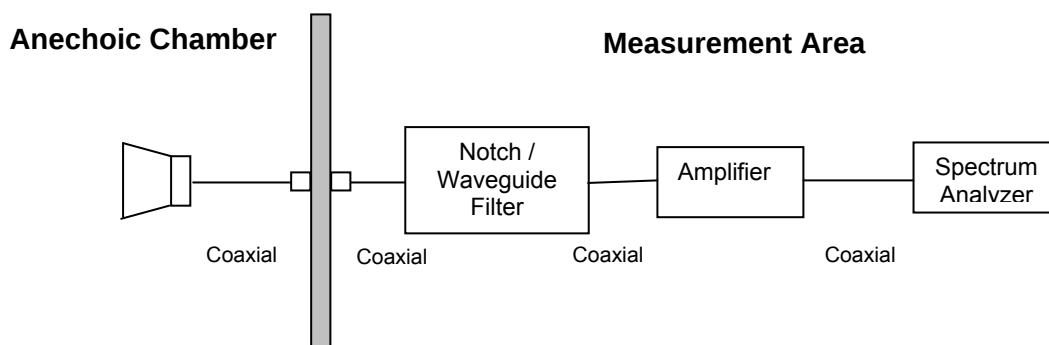
Industry Canada RSS-Gen §4.8, §6

Test Procedure

Radiated emissions above 1 GHz are measured in the anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarities. The emissions are recorded and maximized as a function of azimuth by rotation through 360° with a spectrum analyzer in peak hold mode. Depending on the frequency band spanned a notch filter and waveguide filter was used to remove the fundamental frequency. The highest emissions relative to the limit are listed for each frequency spanned.

All measurements on any frequency or frequencies over 1 MHz are based on the use of measurement instrumentation employing an average detector function. All measurements above 1 GHz were performed using a minimum resolution bandwidth of 1 MHz.

Test Measurement Set up



Measurement set up for Radiated Emission Test

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

$$FS = R + AF + CORR - FO$$

where: FS = Field Strength

R = Measured Spectrum analyzer Input Amplitude

AF = Antenna Factor

CORR = Correction Factor = CL – AG + NFL

CL = Cable Loss

AG = Amplifier Gain

FO = Distance Falloff Factor

NFL = Notch Filter Loss or Waveguide Loss



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For example:

Given receiver input reading of 51.5 dB μ V; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength of the measured emission is:

$$FS = 51.5 + 8.5 + 1.3 - 26.0 + 1 = 36.3 \text{ dB}\mu\text{V/m}$$

Conversion between dB μ V/m (or dB μ V) and μ V/m (or μ V) are done as:

$$\text{Level (dB}\mu\text{V/m)} = 20 * \text{Log (level (\mu V/m))}$$

$$40 \text{ dB}\mu\text{V/m} = 100 \mu\text{V/m}$$

$$48 \text{ dB}\mu\text{V/m} = 250 \mu\text{V/m}$$

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Receiver Radiated Spurious Emissions above 1 GHz

2.4 GHz Operational Mode

Receiver results cover all variants

802.11b, 2437 MHz Configuration Peak Emissions

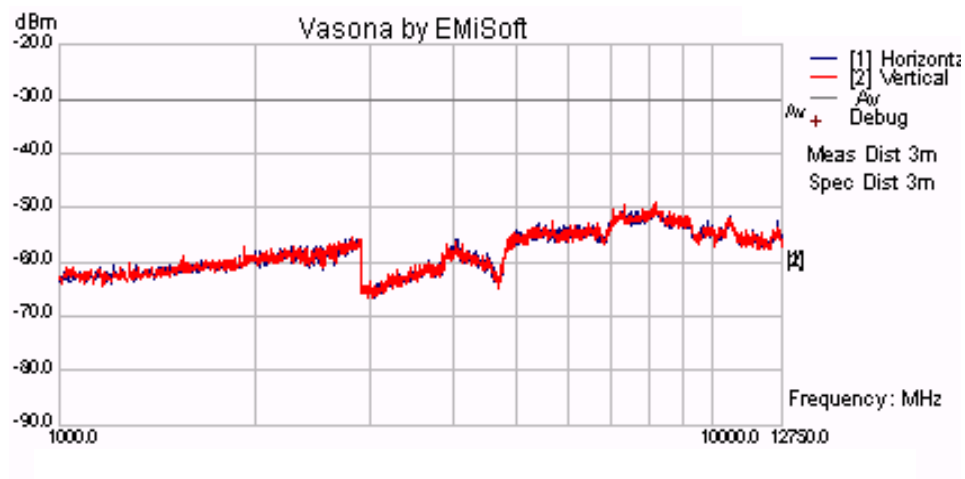


TABLE OF RESULTS

Freq. (MHz)	Pol. (H/V)	Corrected Peak Field Strength (dB μ V/m)	Corrected Average Field Strength (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)

No Spurious emissions were found

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Specification

Receiver Radiated Spurious Emissions

Industry Canada RSS-Gen §4.8,

The search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is the higher, to at least 3 times the highest tunable or local oscillator frequency, whichever is the higher, without exceeding 40 GHz.

RSS-Gen §6

The following receiver spurious emission limits shall be complied with;

(a) If a radiated measurement is made, all spurious emissions shall comply with the limits of Table 1.

Frequency (MHz)	Field Strength (μ V/m)	Field Strength (dB μ V/m)	Measurement Distance (meters)
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

Laboratory Measurement Uncertainty for Radiated Emissions

Measurement uncertainty	+5.6/ -4.5 dB
-------------------------	---------------

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions'	0088, 0158, 0134, 0304, 0311, 0315, 0310, 0312

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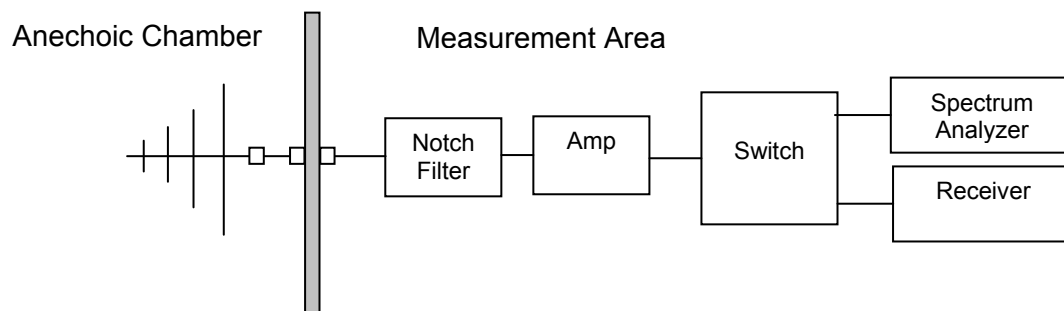
5.1.5.3. Radiated Spurious Emissions (30M-1 GHz)

FCC, Part 15 Subpart C §15.205/ §15.209
Industry Canada RSS-210 §2.2

Test Procedure

Preliminary radiated emissions are measured in the anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarity. The emissions are recorded with a spectrum analyzer in peak hold mode. Emissions closest to the limits are measured in the quasi-peak mode with the tuned receiver using a bandwidth of 120 kHz. Only the highest emissions relative to the limit are listed. The anechoic chamber test set-up is identified in Section 6 Test Set-Up Photographs.

Test Measurement Set up





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Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. In this test facility, the Antenna Factor, Cable Loss, and Amplifier Gains are loaded into the Rohde & Schwarz Receiver and the corrected field strength can be read directly on the receiver.

$$FS = R + AF + CORR$$

where:

FS = Field Strength

R = Measured Receiver Input Amplitude

AF = Antenna Factor

CORR = Correction Factor = CL – AG + NFL

CL = Cable Loss

AG = Amplifier Gain

For example:

Given a Receiver input reading of 51.5dB μ V; Antenna Factor of 8.5dB; Cable Loss of 1.3dB; Falloff Factor of 0dB, an Amplifier Gain of 26dB and Notch Filter Loss of 1dB. The Field Strength of the measured emission is:

$$FS = 51.5 + 8.5 + 1.3 - 26.0 + 1 = 36.3\text{dB}\mu\text{V/m}$$

Conversion between dB μ V/m (or dB μ V) and μ V/m (or μ V) are done as:

$$\text{Level (dB}\mu\text{V/m)} = 20 * \text{Log (level (\mu V/m))}$$

$$40 \text{ dB}\mu\text{V/m} = 100\mu\text{V/m}$$

$$48 \text{ dB}\mu\text{V/m} = 250\mu\text{V/m}$$

Measurement Results for Spurious Emissions (30 MHz – 1 GHz)

Ambient conditions.

Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

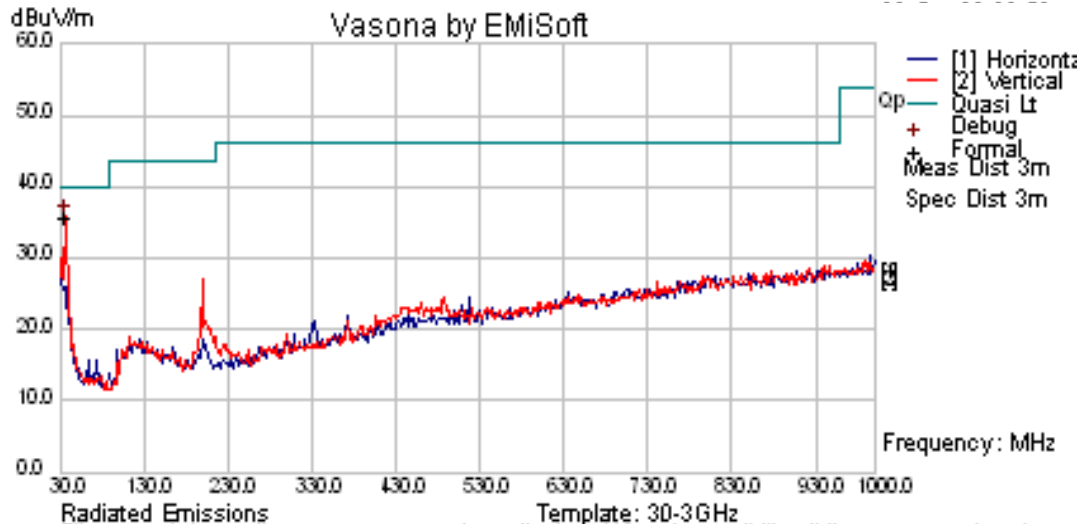
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TABLE OF RESULTS

DSSS Transmission Radiated Spurious Emissions 30 MHz to 1 GHz Orientation X



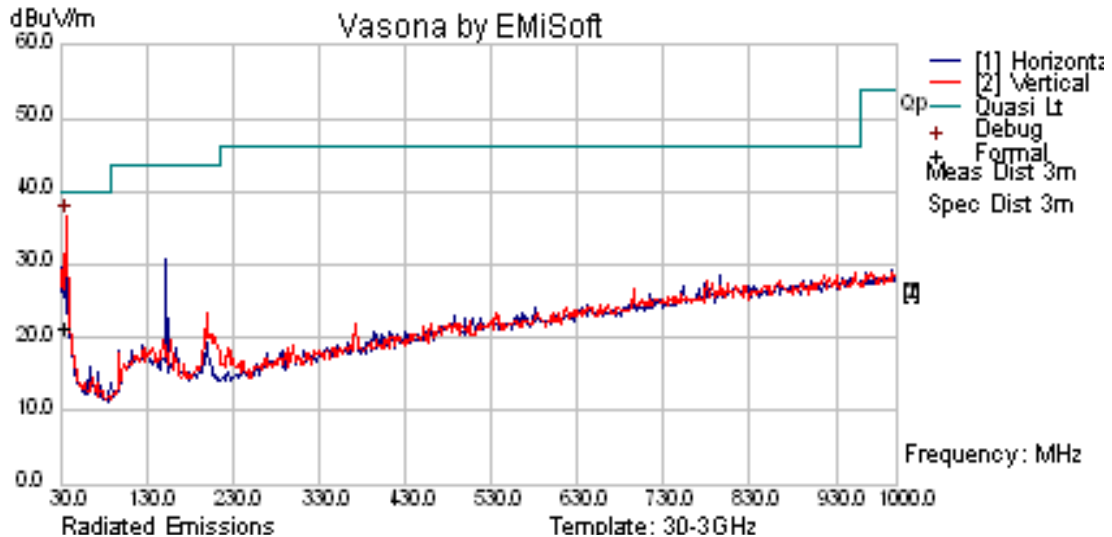
Freq. (MHz)	Peak (dBuV/m)	QP (dBuV/m)	QP Lmt (dBuV/m)	QP Margin (dB)	Angle (deg)	Height (cm)	Polarity
36.056	35.73	21.3	40	-18.7	323	169	V

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DSSS Transmission Radiated Spurious Emissions 30 MHz to 1 GHz Orientation Y



Freq. (MHz)	Peak (dBuV/m)	QP (dBuV/m)	QP Lmt (dBuV/m)	QP Margin (dB)	Angle (deg)	Height (cm)	Polarity

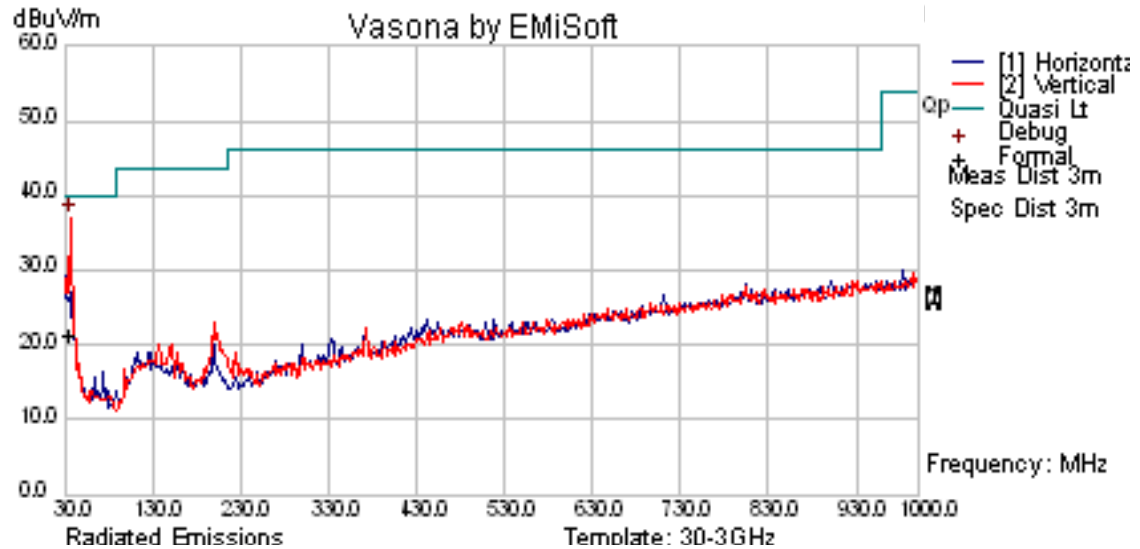
No emissions were found within 6 dB of the limit

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DSSS Transmission Radiated Spurious Emissions 30 MHz to 1 GHz Orientation Z



Freq. (MHz)	Peak (dBuV/m)	QP (dBuV/m)	QP Lmt (dBuV/m)	QP Margin (dB)	Angle (deg)	Height (cm)	Polarity

No emissions were found within 6 dB of the limit

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Specification

Limits

§15.205 (a) Except as shown in paragraph (d) of 15.205 (a), only spurious emissions are permitted in any of the frequency bands listed.

§15.205 (a) Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

§15.209 (a) and RSS-Gen §2.2 Limit Matrix

Frequency(MHz)	Field Strength (μ V/m)	Field Strength (dB μ V/m)	Measurement Distance (meters)
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

Laboratory Measurement Uncertainty for Radiated Emissions

Measurement uncertainty	+5.6/ -4.5 dB
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Traceability

Method	Test Equipment Used
Measurements were made per Sanmina work instruction	8546A HP Receiver and RF Filter, HP Pre-amp, Antenna EMCO Biconilog

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5.1.6. AC Wireline Conducted Emissions (150 kHz – 30 MHz)

FCC, Part 15 Subpart C §15.207

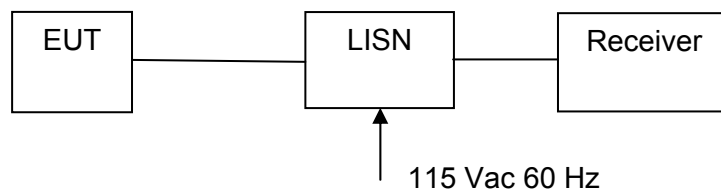
Industry Canada RSS-Gen §7.2.2

Test Procedure

The EUT is configured in accordance with ANSI C63.4. The conducted emissions are measured in a shielded room with a spectrum analyzer in peak hold in the first instance. Emissions closest to the limit are measured in the quasi-peak mode (QP) with the tuned receiver using a bandwidth of 9 kHz. The emissions are maximized further by cable manipulation. The highest emissions relative to the limit are listed.

All six transmitters were operational and terminated in a 50Ω load.

Test Measurement Set up



Measurement set up for AC Wireline Conducted Emissions Test

Measurement Results for AC Wireline Conducted Emissions (150 kHz – 30 MHz)

No test required the device was battery operated



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Specification

Limit

§15.207 (a) Except as shown in paragraphs (b) and (c) of this section, 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 in the following table, as measured using a 50 $\mu\Omega$ line impedance stabilization network (LISN), see §15.207 (a) matrix below. Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal.

RSS-Gen §7.2.2

The radio frequency voltage that is conducted back into the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in the table below. The tighter limit applies at the frequency range boundaries.

§15.207 (a) and **RSS-Gen §7.2.2** Limit Matrix

The lower limit applies at the boundary between frequency ranges

Frequency of Emission (MHz)	Conducted Limit (dB μ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency

Laboratory Measurement Uncertainty for Conducted Emissions

Measurement uncertainty	± 2.64 dB
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Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-EMC-01 'Measurement of Conducted Emissions'	0158, 0184, 0193, 0190, 0293, 0307

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6. PHOTOGRAPHS

6.1. Radiated Emissions (Below 1 GHz)



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6.2. General Measurement Test Set-Up



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7. TEST EQUIPMENT DETAILS

Asset #	Instrument	Manufacturer	Part #	Serial #
0088	Spectrum Analyzer	Hewlett Packard	8564E	3410A00141
0104	1-18GHz Horn Antenna	The Electro-Mechanics Company	3115	9205-3882
0134	Amplifier		PA 122	181910
0158	Barometer /Thermometer	Control Co.	4196	E2846
0193	EMI Receiver	Rhode & Schwartz	ESI 7	838496/007
0252	SMA Cable	Megaphase	Sucoflex 104	None
0304	2.4GHzHz Notch Filter	Micro-Tronics	--	001
0310	2m SMA Cable	Micro-Coax	UFA210A-0-0787-3G03G0	209089-001
0312	3m SMA Cable	Micro-Coax	UFA210A-1-1181-3G0300	209092-001
0313	Coupler	Hewlett Packard	86205A	3140A01285
0314	30dB N-Type Attenuator	ARRA	N9444-30	1623
0070	Power Meter	Hewlett Packard	437B	3125U11552
0116	Power Sensor	Hewlett Packard	8485A	3318A19694
0117	Power Sensor	Hewlett Packard	8487D	3318A00371
0184	Pulse Limiter	Rhode & Schwartz	ESH3Z2	357.8810.52
0190	LISN	Rhode & Schwartz	ESH3Z5	836679/006
0293	BNC Cable	Megaphase	1689 1GVT4	15F50B001
0307	BNC Cable	Megaphase	1689 1GVT4	15F50B002

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