Test of Zebra Enterprise Solutions Corp WhereTag IV
Module

To: FCC 47 CFR Part 15, SubPart 15.247 and RSS-210 Annex 8

Test Report Serial No.: ETSD21-U1 Rev A



# **TEST REPORT**

FROM



Test of: Zebra Enterprise Solutions Corp WhereTag IV Module

To: FCC 47 CFR Part 15, SubPart 15.247 and RSS-210 Annex 8

Test Report Serial No.: ETSD21-U1 Rev A

This report supersedes: NONE

**Applicant:** Zebra Enterprise Solutions Corp

2940 N. First Street San Jose, CA 95134

USA

**Product Function:** Remote Telemetry Module

Copy No: pdf Issue Date: 2nd August 2010

# This Test Report is Issued Under the Authority of;

### MiCOM Labs, Inc.

440 Boulder Court, Suite 200 Pleasanton, CA 94566 USA Phone: +1 (925) 462-0304

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www.micomlabs.com



CERTIFICATE #2381.01

MiCOM Labs is an ISO 17025 Accredited Testing Laboratory



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# 1 ACCREDITATION, LISTINGS & RECOGNITION

### 1.1 ACCREDITATION

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



# Accredited Laboratory

A2LA has accredited

# **MICOM LABS**

Pleasanton, CA for technical competence in the field of

#### **Electrical Testing**

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).



Presented this 14th day of April 2010.

President & CEO
For the Accreditation Council
Certificate Number 2381.01
Valid to November 30, 2011

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



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### 1.2 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 (IC) Listing #: 4143A

### **Japan Registration**

VCCI Membership Number: 2959

Radiated 3 meter site; Registration No. R-2881

• Line Conducted, Registration Nos. C-3181 & T-1470

• Emissions; Registration Nos. C-3180 & T-1469

### 1.3 **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	
Hong Kong	Office of the Telecommunication Authority (OFTA)	I	
Korea	Ministry of Information and Communication Radio Research Laboratory (RRL)		US0159
Singapore	Infocomm Development Authority (IDA)	l	
Taiwan	National Communications Commission (NCC) Bureau of Standards, Metrology and Inspection (BSMI)		
Vietnam	Ministry of Information and Communications	ı	



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# 2 **DOCUMENT HISTORY**

	Document History							
Revision	Date	Comments						
Draft								
Rev A	2 <sup>nd</sup> August 2010	Initial Release						



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# 3 TEST RESULT CERTIFICATE

Applicant:	Zebra Enterprise Solutions Corp 2940 N. First Street San Jose CA, 95134, USA	Tested By:	MiCOM Labs, Inc. 440 Boulder Court Suite 200 Pleasanton California, 94566, USA
Product:	WhereTag IV Module	Telephone:	+1 925 462 0304
Model No.:	TFF-2005	Fax:	+1 925 462 0306
S/No's:	33560876 / 33560868		
Date(s) Tested:	6/28/2010	Website:	www.micomlabs.com

### STANDARD(S)

**TEST RESULTS** 

FCC 47 CFR Part 15, SubPart 15.247 & RSS-210 Annex 8

**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

ACCREDITED

Graeme, Grieve

Quality Manager MiCOM Labs,

Gordon Hurst

President & CEO MiCOM Labs, Inc.



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# 4 REFERENCES AND MEASUREMENT UNCERTAINTY

# 4.1 Normative References

Ref.	Publication	Year	Title			
i.	47 CFR Part 15, SubPart 15.247	2007	For Digitally Modulated Intentional Radiators			
ii.	Industry Canada RSS- 210	Issue 7 June 2007	Low Power License-Exempt Radiocommunication Devices (All Frequency Bands): Category 1 Equipment			
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	2005	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 <sup>th</sup> September 2005	Reference to A2LA Accreditation Status – A2LA Advertising Policy			



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### 4.2 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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# 5 TEST SUMMARY

**List of Measurements:** The following table represents the list of measurements required under FCC 47 CFR Part 15, SubPart 15.247

Standard Section(s)			Result	Test Report Section
(a)(2)	6 dB Occupied Bandwidth	Conducted	Compliant	7.1
(b)(3), (b)(4)	Peak Output Power	Conducted	Compliant	7.2
(e)	Peak Power Spectral Density	Conducted	Compliant	7.3
(i) Maximum Permissible Exposure		Calculation	Compliant	7.4
(d) Spurious Emissions		Conducted	Compliant	7.5
(d), 15.205, Transmitter Radiated 15.209 Spurious Emissions Above 1 GHz		Radiated	Compliant	7.6 / 7.7*
(d), 15.205, Radiated Band-Edge 15.209		Radiated	Compliant	7.6 / 7.7*
4.10, 6 Receiver Emissions		Radiated	Compliant	7.6 / 7.7*
(d), 15.205, Radiated Transmitter 15.209 Spurious emissions below 1 GHz		Radiated	Compliant	7.8
15.207 AC Wireline Emissions 0.15 – 30 MHz		Conducted	N/A	7.9

<sup>\*</sup> Section 7.6 results are for antenna ZES 10370

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:** Section 6.11 Equipment Modifications highlights the equipment modifications that were required to bring the product into compliance with the above test matrix

<sup>\*</sup> Section 7.7 results are for antenna Taoglas FXP73.07.0100A



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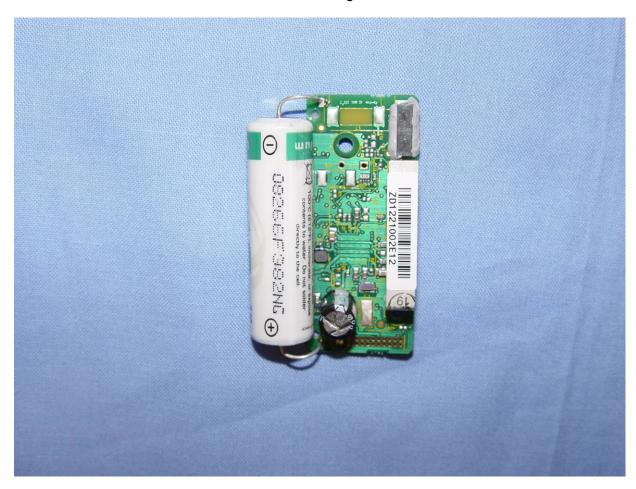
# 6 PRODUCT DETAILS AND TEST CONFIGURATIONS

### 6.1 <u>Test Program Scope</u>

The scope of the test program was to test the Zebra Enterprise Solutions Corp WhereTag IV MODULE Remote Telemetry Module for compliance against FCC 47 CFR Part 15, SubPart 15,247

**Applicant:** Zebra Enterprise Solutions Corp

Product: WhereTag IV Module





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**Applicant:** Zebra Enterprise Solutions Corp

**Product:** Where Tag IV Module





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# 6.2 **EUT Details**

Detail	Description
Purpose:	Test of the Zebra Enterprise Solutions Corp WhereTag IV Module Remote Telemetry Module for compliance against FCC 47 CFR Part 15, SubPart 15.247 and RSS-210 Annex 8
Applicant:	Zebra Enterprise Solutions Corp 2940 N. First Street San Jose CA, 95134, USA
Manufacturer:	As Applicant
Test Laboratory:	MiCOM Labs, Inc. 440 Boulder Court, Suite 200 Pleasanton, California 94566 USA
Test report reference number:	ETSD21
Date EUT received:	6/28/2010
Dates of test (from - to):	6/28/2010
No of Units Tested:	1
Product Name:	WhereTag IV Module
Manufacturers Trade Name:	WhereTag IV Module
Model No.:	TFF-2005
Equipment Primary Function:	Remote Telemetry Module
Equipment Secondary Function(s):	N/A
Type of Technology:	802.11/ ISO24730
Installation type:	Mobile
Construction/Location for Use:	Indoor/Outdoor
Software/Firmware Release:	Prod 3.1.2(0)
Hardware Release:	Rev 01
Test Software Release:	Test 3.1.2(2)
Transmit/Receive Operation:	Simplex
Output Power Type:	Stepped 1 dB
AutomaticTransmit Power Control Available:	No
Remote Frequency Control Available:	No
Rated Input Voltage and Current AC:	Battery Operation only
Operating Frequency:	2400 to 2483 MHz
Rated Input Voltage and Current DC:	Nominal: 3.3V Max: 3.7V Min: 3.0V
	Current: 0.2 (A)
Operating Temperature Range °C:	Min: -30 Max: 70



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ITU Emission Designator(s):	802.11b:	17M7W7D
	802.11g:	24M5D1D
	ISO 24730 DSSS:	44M4W7D
	ISO 24730 OOK:	10M1W7D
Long Term Frequency Stability:	1 PPM/year (+/-25PI	PM / 7 years)
Equipment Dimensions:	6.6x4.4x2.1cm	
Weight:	51 gram	

### 6.3 External A.C/D.C Power Adaptor

No External A.C./D.C. Power adaptor utilized during this test program

# 6.4 Operational Power Range

Declared O/P Power Range	Mode 1		Mode 2		Mode 3		Mode 4	
	Max	Min	Max	Min	Max	Min	Max	Min
EUT	10	0	10	0	15	0	2	-2

### 6.5 Types of Modulation Supported

Modes	Modulation / Mode	Type
Mode 1	802.11b	BPSK,QPSK, CCK
Mode 2	802.11g	OFDM
Mode 3	ISO24730 DSSS	BPSK
Mode 4	ISO24730 OOK	ASK

### 6.6 Antenna Details

The following is a description of the EUT antennas.

Antenna Type:	Manufacturer	Model	Gain (dBi)	Frequency Range (MHz)
Inverted-F	ZES	10370	2 max	2400-2483.5
Flexible	Taoglas	FXP73.07.0100A	2.5	2400-2483.5



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# 6.7 Cabling and I/O Ports

The following is a description of the cable and input, output ports available on the EUT.

Type of I/O Ports	Description	Screened (y/n)	Description	Qty	Tested
Serial Programming	20-pin header	N/A	< 1m	1	N/A

### 6.8 **EUT Configurations**

### **LEGACY**

Band (GHz)	Mode	Freq Band (MHz)	Freq Range (MHz)	Low ch	Mid ch	High ch	# Ch	Channel Spacing (MHz)	Channel BW (MHz)
2.4	802.11 b	2400 - 2483.5	2412 - 2462	2412	2437	2462	11	5	20
2.4	802.11 g	2400 - 2483.5	2412 - 2462	2412	2437	2462	11	5	20
2.4	ISO24730 DSSS	2400 - 2483.5	2412 - 2462		2441.75		1		67
2.4	ISO24730 OOK	2400 - 2483.5	2412 - 2462		2446.519		1		10

### 6.9 **Equipment Details**

The following is a description of EUT and supporting equipment used during the test program.

Type (EUT/Support)	Equipment Description	Manufacturer	Model No.	Part No (s).
EUT	Remote Telemetry Module (w/ Antenna ZES10370) s/n 33560876	Zebra Enterprise Solutions Corp	TFF-2005	TFF-2005- 00AA
EUT	Remote Telemetry Module (w/ Antenna FXP73.07.0100A) s/n 33560868	Zebra Enterprise Solutions Corp	TFF-2005	TFF-2005- 00AA
Support	Laptop PC	Dell	PPX	72MUF A02
Support	Laptop PC	Dell	PPL	9172P
Support	Location Sensor	Zebra Enterprise Solutions Corp.	LOS-4100	01AC



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# 6.10 Test Configurations

Operational Mode(s)	Data Rate Tested	Duty Cycle
b	1 MBit/s	100
g	6 MBit/s	100
ISO24730 DSSS	59.7 kbps	100
ISO24730 OOK	19.833 kbps	100

### **6.11 Equipment Modifications**

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

No modifications required.

### 6.12 <u>Deviations from the Test Standard</u>

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

No deviations required.



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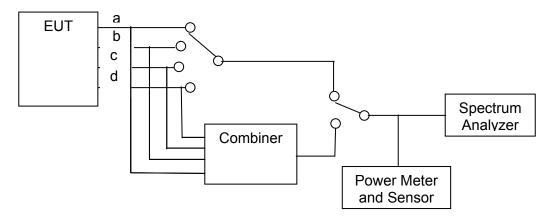
# 7 TEST RESULTS

### 7.1 6 dB and 99% Bandwidth

### **Test Procedure**

The test methodology and conditions utilized for each measurement is referenced in the following test results matrix. 6 dB and 99% bandwidth were measured per the Test Configuration identified below.

### **Test Configuration**



Test configuration for 6 dB & 99% Bandwidth

### **Specification**

### Limits

§15.247 (a)(2)

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

**Traceability** 

Method	Test Equipment Used
Measurements were made per work	0158, 0252, 0313, 0314, 0116, 0117, 0287, 0363
instruction WI-03 'Measurement of RF	
Spectrum Mask'	



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### 7.1.1 6 dB and 99% Bandwidth Results: 802.11 b

Test Conditions:	15.247 (a)(2)	Rel. Humidity (%):	35	to	42
Variant:	802.11 b	Ambient Temp. (°C):	19	to	22
TPC:	HIGH	Pressure (mBars):	998	to	1003
Modulation:	ON	Duty Cycle (%):	100		
Beam Forming Gain (Y):	N/A dB	Antenna Gain:	2	dBi	
Applied Voltage:	3.6V Vdc				
Notes 1:					
Notes 2:					

### 6 dB Bandwidth

Test Frequency	6 dB Bandwidth MHz			Minimum Bandwidth		Margin	
MHz	а	b	С	d	kHz	MHz	MHz
2412	10.100000						-9.600000
2437	10.100000				500	0.5	-9.600000
2462	10.180000						-9.680000

### 99% Bandwidth

Test	99 % Bandwidth					
Frequency	MHz					
MHz	а	b	С	d		
2412	17.876000					
2437	16.513000					
2462	17.715000					

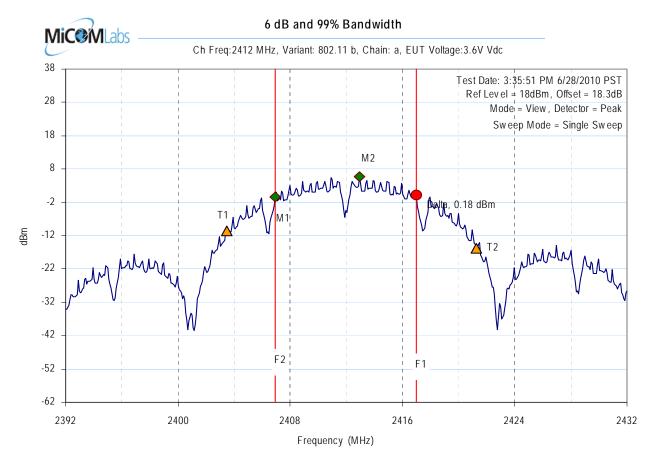
Measurement uncertainty:	±2.81 dB



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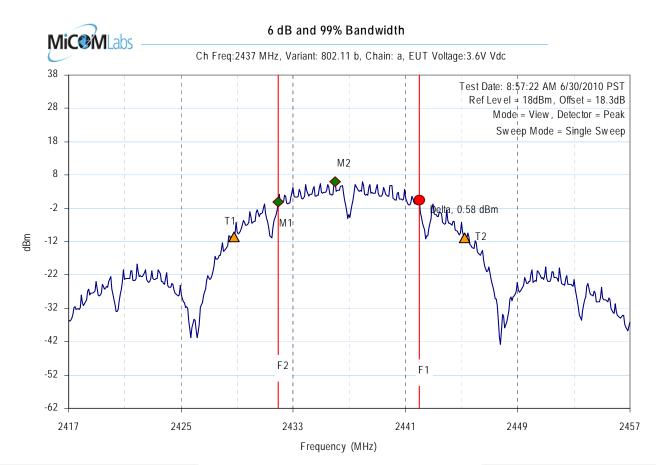
Analyser Setup	Marker : Frequency : Amplitude	Test Results
RBW = 100.00KHz	M1: 2406.909820MHz:353dBm	Center frequency = 2412MHz
VBW = 300.00KHz	M2: 2412.921844MHz: 5.765dBm	6dB BW(Delta-M1) = 10.100200MHz
Sw eep time(s) = 20	Delta: 2417.010020MHz: .184dBm	99% OBW(T2-T1) = 17.875752MHz
RF Atten (dB) = 10	T1: 2403.462926MHz: -10.493dBm	
Span = 40.00MHz	T2: 2421.258517MHz: -15.815dBm	



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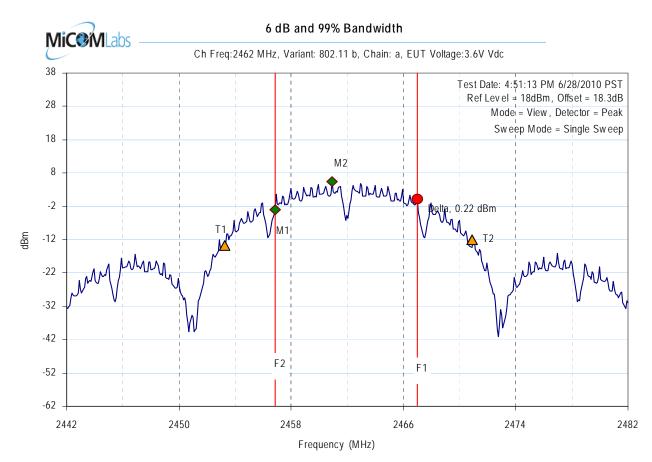
Analyser Setup	Marker : Frequency : Amplitude	Test Results
RBW = 100.00KHz	M1: 2431.909820MHz:226dBm	Center frequency = 2437MHz
VBW = 300.00KHz	M2: 2435.997996MHz: 6.147dBm	6dB BW(Delta-M1) = 10.100200MHz
Sweep time(s) = $20$	Delta: 2442.010020MHz: .577dBm	99% OBW(T2-T1) = 16.513026MHz
RF Atten (dB) = 10	T1: 2428.783567MHz: -10.586dBm	
Span = 40.00MHz	T2: 2445.216433MHz: -10.773dBm	



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Analyser Setup	Marker : Frequency : Amplitude	Test Results
RBW = 100.00KHz	M1: 2456.829659MHz: -2.880dBm	Center frequency = 2462MHz
VBW = 300.00KHz	M2: 2460.917836MHz: 5.322dBm	6dB BW(Delta-M1) = 10.180361MHz
Sw eep time(s) = $20$	Delta: 2467.010020MHz: .221dBm	99% OBW(T2-T1) = 17.715431MHz
RF Atten (dB) = 10	T1: 2453.222445MHz: -13.676dBm	
Span = 40.00MHz	T2:2470.857715MHz:-12.073dBm	



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### 7.1.2 6 dB and 99% Bandwidth Results: 802.11 g

Test Conditions:	15.247 (a)(2)	Rel. Humidity (%):	35	to	42
Variant:	802.11 g	Ambient Temp. (°C):	19	to	22
TPC:	HIGH	Pressure (mBars):	998	to	1003
Modulation:	ON	Duty Cycle (%):	100		
Beam Forming Gain (Y):	N/A dB	Antenna Gain:	2	dBi	
Applied Voltage:	3.6V Vdc				
Notes 1:					
Notes 2:					

### 6 dB Bandwidth

Test Frequency	6 dB Bandwidth MHz				Minimum 6dB Bandwidth Limit		Margin
MHz	а	b	С	d	kHz	MHz	MHz
2412	16.192000						-15.692000
2437	16.112000				500	0.5	-15.612000
2462	16.353000						-15.853000

### 99% Bandwidth

Test	99 % Bandwidth					
Frequency	MHz					
MHz	а	b	С	d		
2412	22.285000					
2437	24.529000					
2462	22.926000		1			

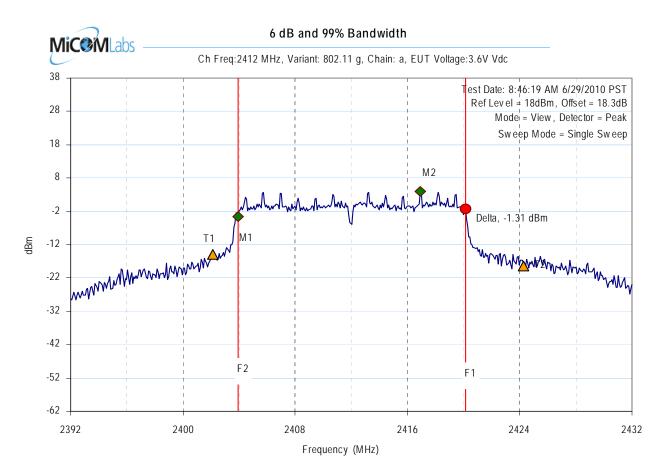
Measurement uncertainty:	±2.81 dB
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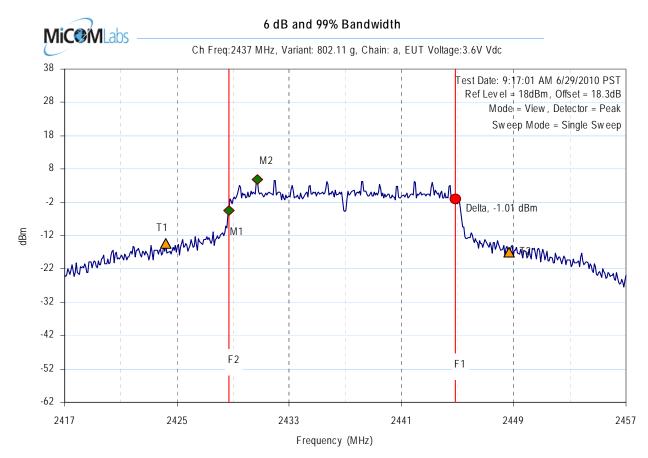
Analyser Setup	Marker : Frequency : Amplitude	Test Results
RBW = 100.00KHz	M1: 2403.943888MHz: -3.613dBm	Center frequency = 2412MHz
VBW = 300.00KHz	M2: 2416.929860MHz: 3.870dBm	6dB BW(Delta-M1) = 16.192385MHz
Sw eep time(s) = $20$	Delta: 2420.136273MHz: -1.310dBm	99% OBW(T2-T1) = 22.284569MHz
RF Atten (dB) = 10	T1: 2402.100200MHz: -14.957dBm	
Span = 40.00MHz	T2:2424.304609MHz:-18.274dBm	



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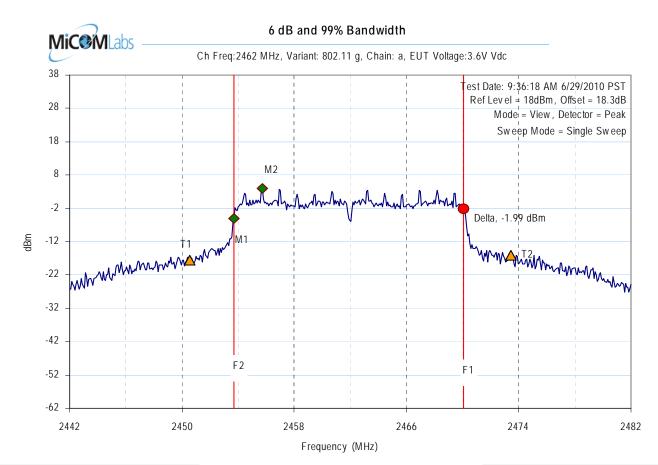
Analyser Setup	Marker : Frequency : Amplitude	Test Results
RBW = 100.00KHz	M1: 2428.703407MHz: -4.410dBm	Center frequency = 2437MHz
VBW = 300.00KHz	M2: 2430.707415MHz: 4.901dBm	6dB BW(Delta-M1) = 16.112224MHz
Sw eep time(s) = 20	Delta: 2444.815631MHz:-1.011dBm	99% OBW(T2-T1) = 24.529058MHz
RF Atten (dB) = 10	T1:2424.214429MHz:-14.221dBm	
Span = 40.00MHz	T2:2448.663327MHz:-16.938dBm	



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Analyser Setup	Marker : Frequency : Amplitude	Test Results
RBW = 100.00KHz	M1: 2453.703407MHz: -5.044dBm	Center frequency = 2462MHz
VBW = 300.00KHz	M2:2455.707415MHz:3.985dBm	6dB BW(Delta-M1) = 16.352705MHz
Sw eep time(s) = $20$	Delta: 2470.056112MHz: -1.986dBm	99% OBW(T2-T1) = 22.925852MHz
RF Atten (dB) = 10	T1:2450.577154MHz:-17.554dBm	
Span = 40.00MHz	T2: 2473.422846MHz: -16.106dBm	



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### 7.1.3 6 dB and 99% Bandwidth Results: DSSS

Test Conditions:	15.247 (a)(2)	Rel. Humidity (%):	35	to	42
Variant:	DSSS	Ambient Temp. (℃):	19	to	22
TPC:	NA	Pressure (mBars):	998	to	1003
Modulation:	ON	Duty Cycle (%):	100		
Beam Forming Gain (Y):	N/A dB	Antenna Gain:	2	dBi	
Applied Voltage:	3.6V Vdc				
Notes 1:		-			
Notes 2:					

#### 6 dB Bandwidth

Test		6 dB Ba	/linimum6dB Margin					
Frequency		MI	Hz		Bandwidth Limit		Iviai gii i	
MHz	а	b	С	d	kHz	MHz	MHz	
2441.75	22.557114	-	-	_	500	0.5	-22.057114	

#### 99% Bandwidth

Test	99 % Bandwidth					
Frequency	MHz					
MHz	а	q	С	d		
2441.75	44.040000	_	-	_		

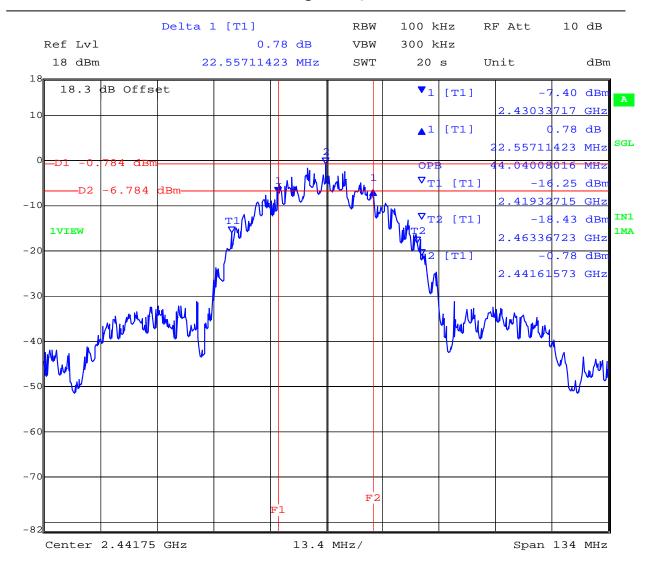
Measurement uncertainty:	±2.81 dB



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Date: 29.JUN.2010 10:45:40



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### 7.1.4 6 dB and 99% Bandwidth Results: OOK

Test Conditions:	15.247 (a)(2)	Rel. Humidity (%):	35	to	42
Variant:	OOK	Ambient Temp. (°C):	19	to	22
TPC:	N/A	Pressure (mBars):	998	to	1003
Modulation:	ON	Duty Cycle (%):	100		
Beam Forming Gain (Y):	N/A dB	Antenna Gain:	2	dBi	
Applied Voltage:	3.6V Vdc				
Notes 1:					
Notes 2:					

#### 6 dB Bandwidth

Test		6 dB Ba		Minimum		Margin			
Frequency		MI	Hz		Bandwidth	Limit	9		
MHz	а	b	С	d	kHz	MHz	MHz		
2446.519	1.202405				500	0.5	-0.702405		

#### 99% Bandwidth

Test		99 % Ba	ndwidth			
Frequency	MHz					
MHz	а	b	С	d		
2446.519	10.020040					

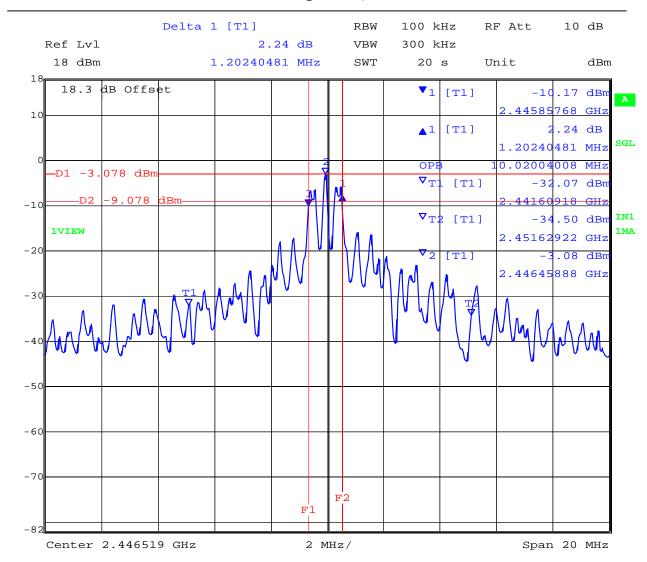
Measurement uncertainty:	±2.81 dB



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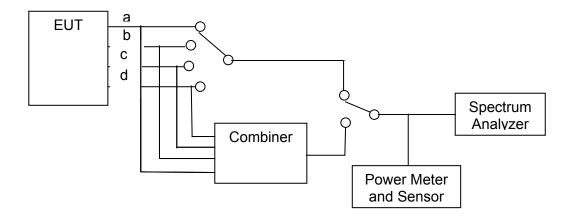
# 7.2 Peak Output Power

### **Test Procedure**

The test methodology and conditions utilized for each measurement is referenced in the test results matrix. The average output power was measured per the test configuration identified below.

Per the standard measurements were taken at ambient conditions, nominal voltage.

### **Test Configuration**



Measurement set-up for Peak Output Power

Total Power =  $A + G + Y + 10 \log (1/x) dBm$ A = Total Power [10 Log10 (10a/10 + 10b/10 + 10c/10 + 10d/10)], G = Antenna Gain, Y = Beam Forming Gain, X = Duty Cycle



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### **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.

15.247 (b) (4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, 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 paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

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 fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted output power.
- §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.

**Traceability** 

Method	Test Equipment Used
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	0158, 0252, 0313, 0314, 0223, 0116, 0117, 0287, 0363



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### 7.2.1 Measurement Results: 802.11 b

Test Conditions:	15.247 (b)	Rel. Humidity (%):	35	to	42
Variant:	802.11 b	Ambient Temp. (°C):	19	to	22
TPC:	HIGH	Pressure (mBars):	998	to	1003
Modulation:	ON	Duty Cycle (%):	100		
Beam Forming Gain	N/A dB	Antenna Gain:	2	dBi	
Applied Voltage:	3.6V Vdc				
Notes 1:					
Notes 2:					

Test Frequency	M	easured F	 er	Total Power (dBm)		Limit	Margin
MHz	MHz a b c d (		Combined	Calculated	dBm	dB	
2412	14.00		 		14.00	30.00	-16.00
2437	16.21		 		16.21	30.00	-13.79
2462	16.00		 		16.00	30.00	-14.00

Measurement uncertainty:	±1.33 dB



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### 7.2.2 Measurement Results: 802.11 g

Test Conditions:	15.247 (b)	Rel. Humidity (%):	35	to	42
Variant:	802.11 g	Ambient Temp. (°C):	19	to	22
TPC:	HIGH	Pressure (mBars):	998	to	1003
Modulation:	ON	Duty Cycle (%):	100		
Beam Forming Gain	N/A dB	Antenna Gain:	2	dBi	
Applied Voltage:	3.6V Vdc				
Notes 1:					
Notes 2:				•	

Test	Measured Peak Power				Total Pow	or (dRm)	Limit	Margin	
Frequency	RF Port (dBm)				TOTALFOW	er (ubili)	Lillit	Wargiii	
MHz	a b c d		d	Combined	Calculated	dBm	dB		
2412	15.19	-		-	15.19	15.19	30.00	-14.81	
2437	15.99				16.00	15.99	30.00	-14.00	
2462	15.13				15.13	15.13	30.00	-14.87	

Measurement uncertainty:	±1.33 dB



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# 7.2.3 <u>Measurement Results: DSSS</u>

Test Conditions:	15.247 (b)	Rel. Humidity (%):	35	to	42
Variant:	ISO 24730 DSSS	Ambient Temp. (°C):	19	to	22
TPC:	HIGH	Pressure (mBars):	998	to	1003
Modulation:	ON	Duty Cycle (%):	100		
<b>Beam Forming Gain</b>	N/A dB	Antenna Gain:	2	dBi	
Applied Voltage:	3.6V Vdc				
Notes 1:					
Notes 2:					

Test Frequency	Measured Peak Power  RF Port (dBm)			er	Total Pow	ver (dBm)	Limit	Margin	
MHz	а	b	С	d	Combined	Calculated	dBm	dB	
2442	2442 14.91				14.91	30.00	-15.09		
Measurement uncertainty:						±1.33 dB			

### 7.2.4 Measurement Results: OOK

Test Conditions:	15.247 (b)	Rel. Humidity (%):	35	to	42
Variant:	ISO 24730 OOK	Ambient Temp. (°C):	19	to	22
TPC:	HIGH	Pressure (mBars):	998	to	1003
Modulation:	ON	Duty Cycle (%):	100		
<b>Beam Forming Gain</b>	N/A dB	Antenna Gain:	2	dBi	
Applied Voltage:	3.6V Vdc				
Notes 1:					
Notes 2:					

Test Frequency	Measured Peak Power RF Port (dBm)				Total Power (dBm)		Limit	Margin
MHz	а	b	С	d	Combined	Calculated	dBm	dB
2442	1.27					1.27	30.00	-28.73
Measurement uncertainty:					±1.33 dB			



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### 7.3 Peak Power Spectral Density

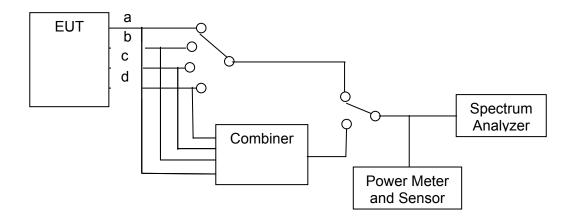
#### **Test Procedure**

The test methodology and conditions utilized for each measurement is referenced in the following test results matrix. RF output power, transmit power control and power density were measured per the Test Configuration identified below.

Testing was performed on the highest and lowest power settings of the equipment.

Per the standard measurements were taken at ambient and extreme temperature conditions at nominal and extreme voltage levels.

### **Test Configuration**



Measurement set-up for Peak Power Spectral Density

### **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

**Traceability** 

Method	Test Equipment Used
Measurements were made per work	0158, 0252, 0313, 0314, 0223, 0116, 0117, 0287,
instruction WI-01 'Measuring RF	0363
Output Power'	



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# 7.3.1 Measurement results for 802.11 b

Test Conditions:	15.247 (e)	Rel. Humidity (%):	35	to	42
Variant:	802.11 b	Ambient Temp. (°C):	19	to	22
TPC:	HIGH	Pressure (mBars):	998	to	1003
Modulation:	ON	Duty Cycle (%):	100		
Beam Forming Gain	N/A dB	Antenna Gain:	2	dBi	
Applied Voltage:	3.6V Vdc				
Notes 1:					
Notes 2:					

Test	M	leasured Po	ower Densi	ty	Total Pe	ak Power	Limit	Margin
Frequency		RF Por	t (dBm)		Spectral Density (dBm)			Wargin
MHz	а	b	С	d	Combined	Calculated	dBm	dB
2412	-9.87					-9.87	8.00	-17.87
2437	-7.95					-7.95	8.00	-15.95
2462	-10.12					-10.12	8.00	-18.12

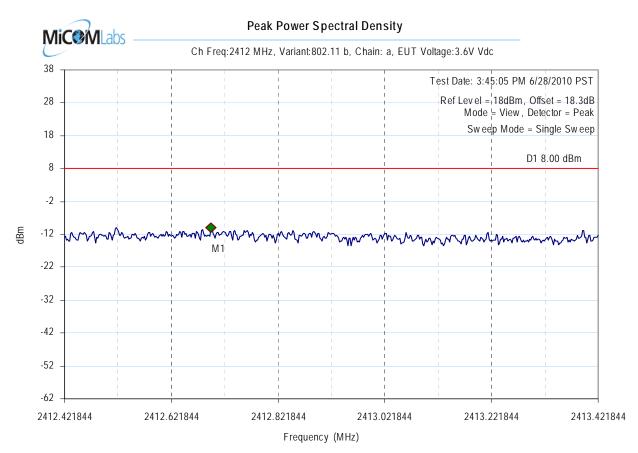
Measurement uncertainty:	± 1.33 dB



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Analyser Setup

RBW = 3.00KHz

VBW = 10.00KHz

Sweep time(s) = 350RF Atten (dB) = 20

Span = 1.00MHz

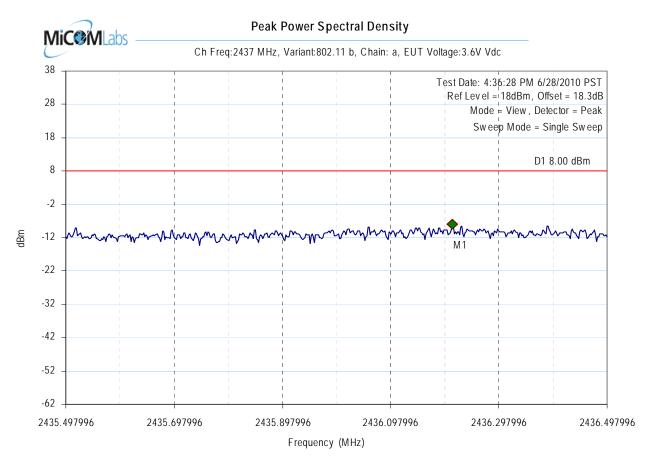
Marker : Frequency : Amplitude Test Results



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Marker: Frequency: Amplitude

M1: 2436.211423MHz: -7.949dBm

Analyser Setup

RBW = 3.00KHz

VBW = 10.00KHz

Sweep time(s) = 350

RF Atten (dB) = 20

Span = 1.00MHz

Test Results

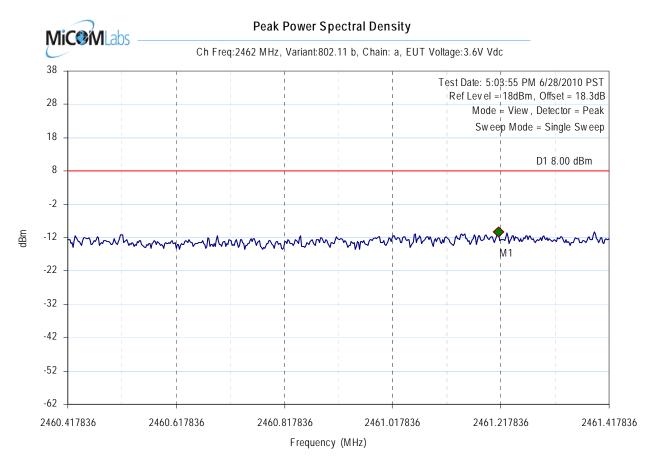
Center frequency = 2437MHz



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Marker: Frequency: Amplitude

M1: 2461.213427MHz: -10.119dBm

Analyser Setup

RBW = 3.00KHz

VBW = 10.00KHz

Sweep time(s) = 350

RF Atten (dB) = 20

Span = 1.00MHz

Test Results

Center frequency = 2462MHz



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# 7.3.2 Measurement results for 802.11 g

Test Conditions:	15.247 (e)	Rel. Humidity (%):	35	to	42
Variant:	802.11 g	Ambient Temp. (°C):	19	to	22
TPC:	HIGH	Pressure (mBars):	998	to	1003
Modulation:	ON	Duty Cycle (%):	100		
Beam Forming	N/A dB	Antenna Gain:	2	dBi	
Applied Voltage:	3.6V Vdc				
Notes 1:					
Notes 2:					

Test Frequency			ower Der t (dBm)	nsity	Total Peak Power Spectral Density (dBm)		Limit	Margin
MHz	а	b	С	d	Combined	Calculated	dBm	dB
2412	-10.36	1	1			-10.36	8.00	-18.36
2437	-9.32	1	1			-9.32	8.00	-17.32
2462	-9.98					-9.98	8.00	-17.98

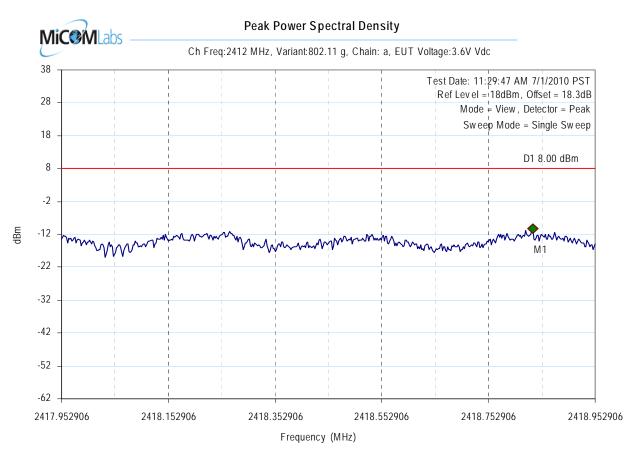
Measurement uncertainty:	± 1.33 dB



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Analyser Setup

RBW = 3.00KHz

VBW = 10.00KHz

Sweep time(s) = 350

RF Atten (dB) = 20

Span = 1.00MHz

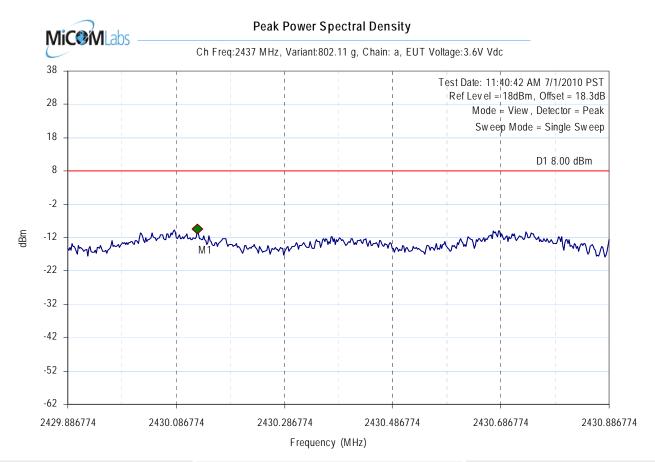
Marker : Frequency : Amplitude Test Results



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Analyser Setup Marker : Frequency : Amplitude Test Results

RBW = 3.00KHz M1 : 2430.125251MHz : -9.317

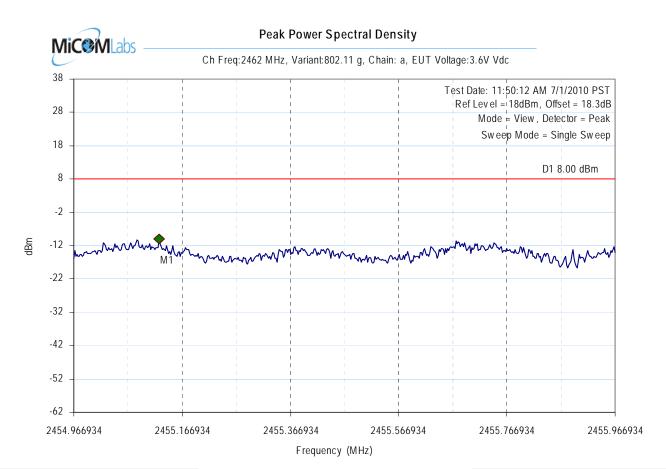
VBW = 10.00KHz Sweep time(s) = 350 RF Atten (dB) = 20 Span = 1.00MHz



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Analyser Setup Marker : Frequency : Amplitude Test Results

VBW = 10.00KHz Sweep time(s) = 350 RF Atten (dB) = 20 Span = 1.00MHz

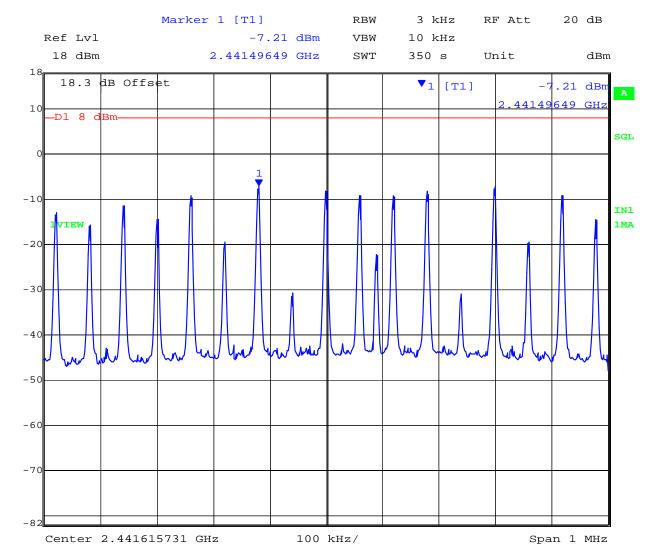


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### 7.3.3 <u>Measurement Results: DSSS</u>



Date: 29.JUN.2010 10:53:39

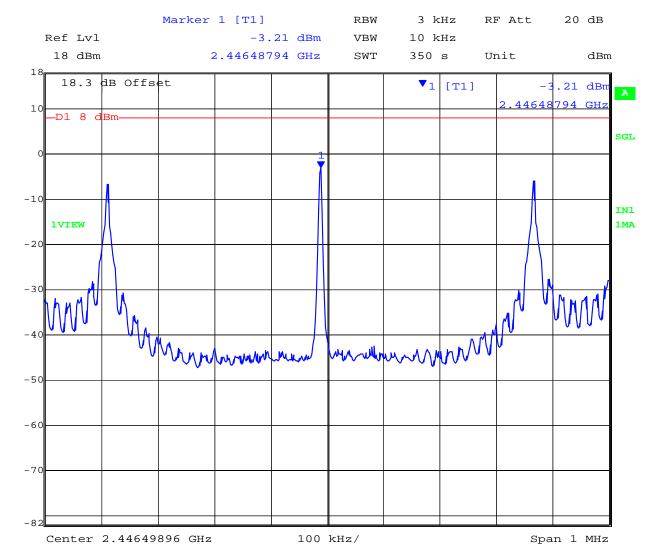


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### 7.3.4 Measurement Results: OOK



Date: 29.JUN.2010 11:18:02



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## 7.4 <u>Maximum Permissible Exposure</u>

#### **NOT APPLICABLE TO EUT**

Calculations for Maximum Permissible Exposure Levels

Power Density = Pd (mW/cm2) = EIRP/ $(4\pi d2)$ 

EIRP = P \* G

P = Peak output power (mW)

G = Antenna numeric gain (numeric)

d = Separation distance (cm)

Numeric Gain =  $10 ^ (G (dBi)/10)$ 

The peak power in the table below is calculated by assuming a worst case scenario where all of the EUT transmitters are operating simultaneously in the same band. The Peak Power in mW is the highest transmitter power measured and summed across all transmitters.

Because the EUT belongs to the General Population/Uncontrolled Exposure the limit of power density is 1.0 mW/cm2

Freq.	Antenna	Peak	Antenna		Distance @	Minimum
Band	Gain	Power	Gain	EIRP	1mW/cm2	Separation
(GHz)	(dBi)	(dBm)	(numeric)	(mW)	Limit(cm)	Distance (cm)
2.4 - 2.5						20

<sup>\*</sup>Note: for mobile or fixed location transmitters the minimum separation distance is 20cm, even if calculations indicate the MPE distance to be less.

#### **Specification**

#### **Maximum Permissible Exposure Limits**

§15.247(i) Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency levels in excess of the Commission's guidelines.

FCC §1.1310 Limit = 1mW / cm2 from 1.310 Table 1

RSS-Gen §5.5 Before equipment certification is granted, the application requirements of RSS-102 shall be met.

### **Laboratory Measurement Uncertainty for Power Measurements**

Measurement uncertain	nty	±1.33 dB



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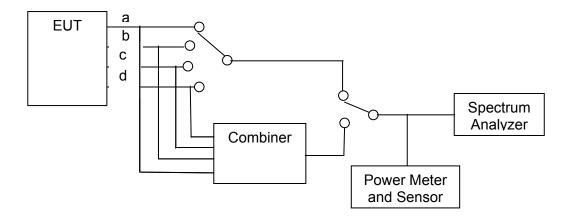
## 7.5 Conducted Spurious Emissions

#### **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.

Measurements were made using a combiner 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 peak emission.

#### **Test Measurement Set Up**



Conducted Spurious Emission measurement test configuration



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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
5725 MHz	5850 MHz	2 20 UB

§15.247(d) 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)).

Traceability

Method	Test Equipment Used
Measurements were made per work	0158, 0252, 0313, 0314, 0223, 0116, 0117, 0287,
instruction WI-05 'Measurement of	0363.
Spurious Emissions'	



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### 7.5.1 Measurement Results for 802.11 b

Test	15.247 (a)(2)	Rel. Humidity (%):	35	to	42
Variant:	802.11 b	Ambient Temp. (°C):	19	to	22
TPC:	HIGH	Pressure (mBars):	998	to	1003
Modulation:	ON	Duty Cycle (%):	100		
Beam Forming	N/A dB	Antenna Gain:	N/A	dBi	
Applied	3.6V Vdc				
Notes 1:					
Notes 2:					

**Conducted Spurious Measurment** 

Test Frequency	Start Frequency	Stop Frequency	Maximum Observed Emission	Limit (20 dB below peak of
MHz	MHz	MHz	dBm	dBm
2412	30.00	26000.00	-24.98	-15.27
2437	30.00	26000.00	-30.17	-14.56
2462	30.00	26000.00	-26.39	-15.23

Band-edge Measurment

	zana sage measarment						
	Test	Band-edge	<b>Emission Amplitude</b>	Limit (20 dB below	Margin		
	Frequency	Frequency	@ Band-edge	peak of			
	MHz	MHz	dBm	dBm	dB		
	2412	2400.00	-27.76	-13.79	-13.98		
Г	2462	2483.50	-46.68	-14.31	-32.37		

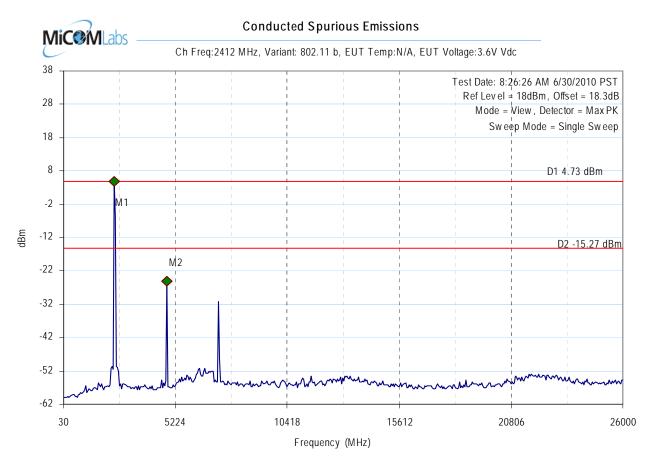
Measurement uncertainty:	±2.81 dB
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Analyser Setup Marker : Frequency : Amplitude Test Results

RBW = 100.00KHz VBW = 300.00KHz Sw eep time(s) = 60RF Atten (dB) = 10

Span = 25.97GHz

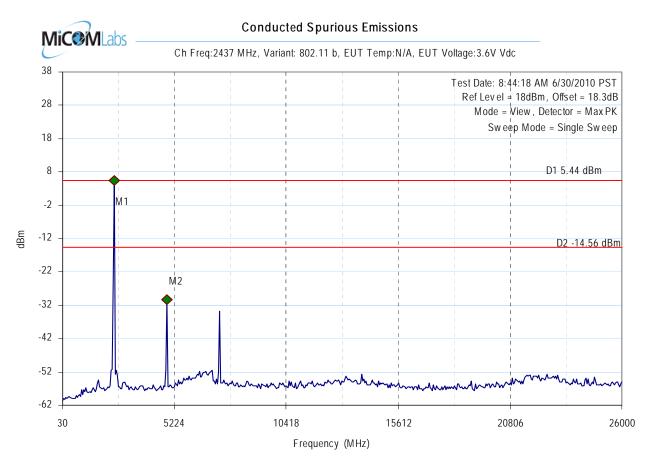
M1: 2371.983968MHz: 4.728dBm M2: 4818.056112MHz: -24.983dBm



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Analyser Setup Marker : Frequency : Amplitude Test Results

M2: 4870.100200MHz: -30.171dBm

RBW = 100.00KHz VBW = 300.00KHz Sw eep time(s) = 60

RF Atten (dB) = 10

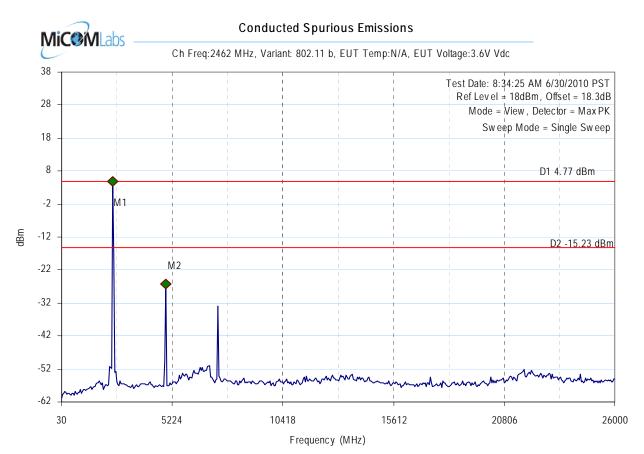
Span = 25.97GHz



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Analyser Setup
RBW = 100.00KHz
VBW = 300.00KHz
Sweep time(s) = 60

RF Atten (dB) = 10Span = 25.97GHz Marker : Frequency : Amplitude Test Results

M1: 2424.028056MHz: 4.775dBm M2: 4922.144289MHz: -26.387dBm Center frequency = 2462MHz



Span = 72.00MHz

**Title:** Zebra Enterprise Solutions Corp

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 Analyser Setup
 Marker : Frequency : Amplitude
 Test Results

 RBW = 100.00KHz
 M1 : 2400.000000MHz : -27.763dBm
 Center frequency = 2412MHz

 VBW = 300.00KHz
 M2 : 2402.809619MHz : -16.718dBm

 Sw eep time(s) = 20
 M3 : 2413.054108MHz : 6.214dBm

 RF Atten (dB) = 10
 RF Atten (dB) = 10



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Analyser Setup

RBW = 100.00KHz

VBW = 300.00KHz

Sweep time(s) = 20

RF Atten (dB) = 10

Span = 72.00MHz

Marker : Frequency : Amplitude

M1: 2460.945892MHz: 5.694dBm

M2: 2471.046092MHz: -15.484dBm M3: 2483.500000MHz: -46.675dBm Test Results

Center frequency = 2462MHz



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### 7.5.2 Measurement Results for 802.11 g

Test Conditions:	15.247 (a)(2)		Rel. Humidity (%):	35	to	42
Variant:	802.11 g		Ambient Temp. (°C):	19	to	22
TPC:	HIGH		Pressure (mBars):	998	to	1003
Modulation:	ON		Duty Cycle (%):	100		
Beam Forming	N/A d	В	Antenna Gain:	N/A	dBi	
Applied Voltage:	3.6V V	dc				
Notes 1:						
Notes 2:						

**Conducted Spurious Measurment** 

Test Frequency	Start Frequency	Stop Frequency	Maximum Observed Emission	Limit (20 dB below peak of fundamental)
MHz	MHz	MHz	dBm	dBm
2412	30.00	26000.00	-33.42	-16.80
2437	30.00	26000.00	-26.87	-18.70
2462	30.00	26000.00	-34.13	-18.80

Band-edge Measurment

Test Frequency	Band-edge Frequency	Emission Amplitude @ Band-edge	Limit (20 dB below peak of	Margin	
MHz	MHz	dBm	dBm	dB	
2412	2400.00	-18.64	-16.17	-2.47	
2462	2483.50	-26.97	-16.16	-10.82	

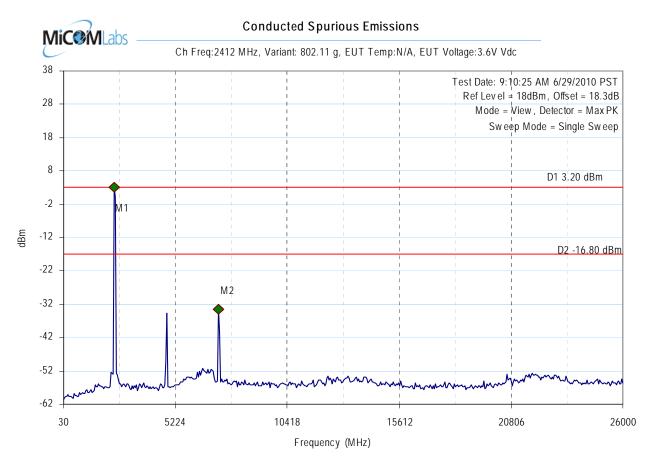
Measurement uncertainty:	±2.81 dB



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Analyser Setup Marker : Frequency : Amplitude Test Results

M2: 7212.084168MHz: -33.415dBm

RBW = 100.00KHz VBW = 300.00KHz Sw eep time(s) = 60

RF Atten (dB) = 10

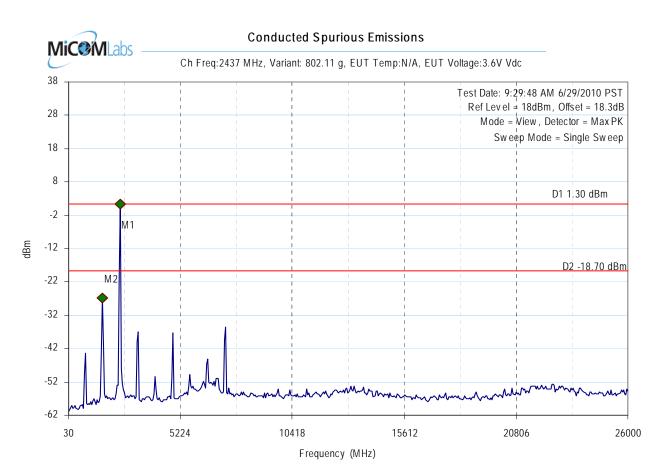
Span = 25.97GHz



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Analyser Setup Marker: Frequency: Amplitude **Test Results** 

RBW = 100.00KHz

VBW = 300.00KHz

Sweep time(s) = 60RF Atten (dB) = 10Span = 25.97GHz

M1: 2424.028056MHz: 1.303dBm

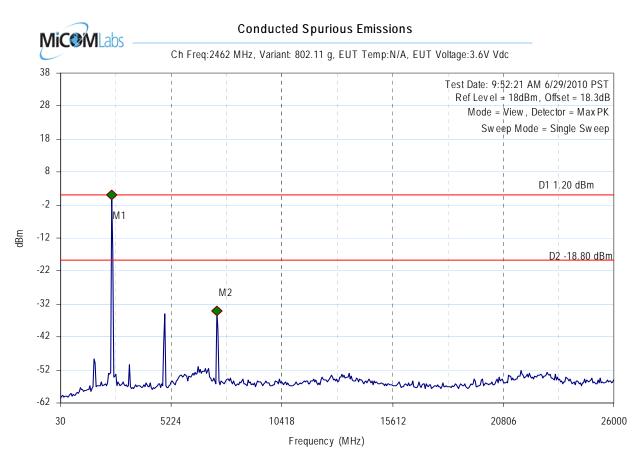
Center frequency = 2437MHz M2: 1591.322645MHz: -26.866dBm



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Analyser Setup RBW = 100.00KHz VBW = 300.00KHz Sw eep time(s) = 60

RF Atten (dB) = 10 Span = 25.97GHz Marker : Frequency : Amplitude

M1: 2424.028056MHz: 1.197dBm M2: 7368.216433MHz: -34.133dBm Test Results

Center frequency = 2462MHz



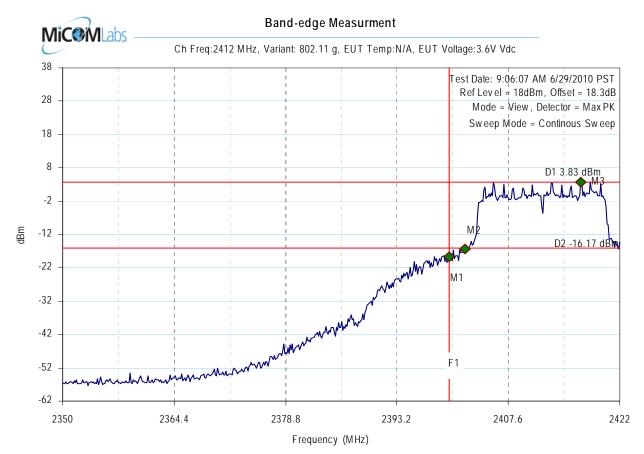
Span = 72.00MHz

Title: Zebra Enterprise Solutions Corp

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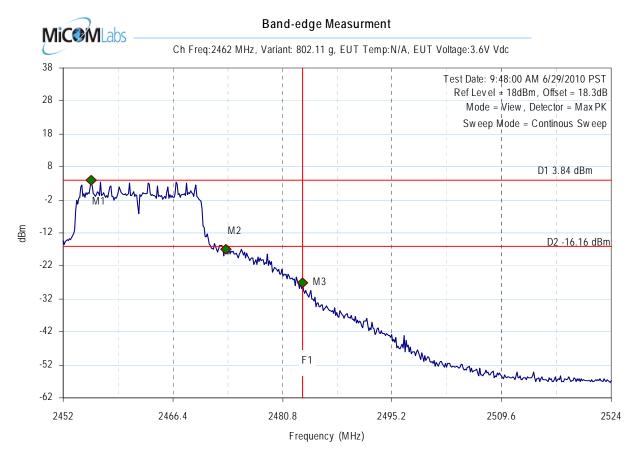
Analyser Setup	Marker : Frequency : Amplitude	Test Results
RBW = 100.00KHz	M1: 2400.000000MHz: -18.640dBm	Center frequency = 2412MHz
VBW = 300.00KHz	M2: 2401.943888MHz: -16.338dBm	
Sw eep time(s) = $20$	M3: 2416.949900MHz: 3.831dBm	
RF Atten (dB) = 10		



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Analyser Setup

RBW = 100.00KHz

VBW = 300.00KHz

Sweep time(s) = 20

RF Atten (dB) = 10

Span = 72.00MHz

Marker : Frequency : Amplitude

M1:2455.607214MHz:3.843dBm M2:2473.354709MHz:-17.005dBm M3:2483.500000MHz:-26.974dBm Test Results

Center frequency = 2462MHz

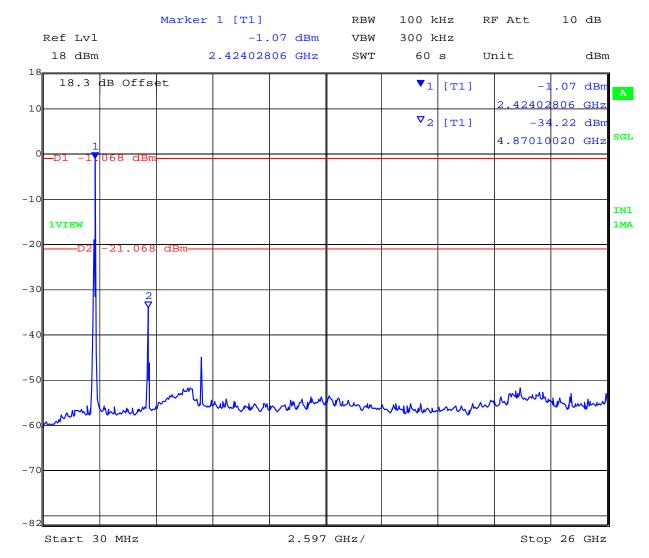


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### 7.5.3 <u>Measurement Results: DSSS</u>



Date: 29.JUN.2010 11:01:10

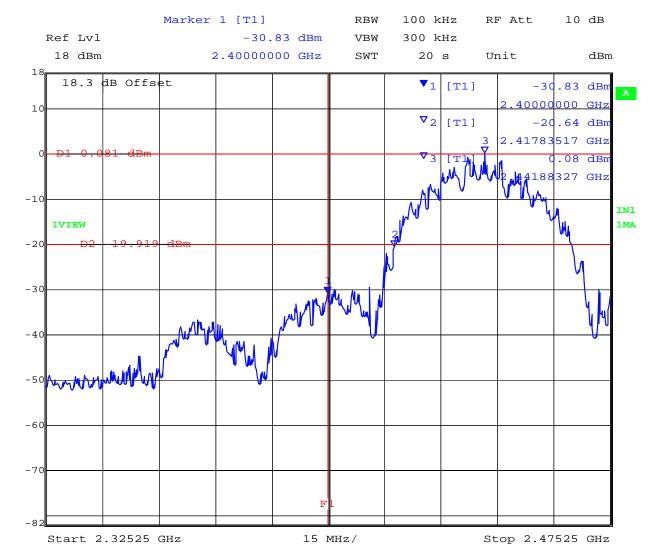


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### Band Edge Ambient 2442MHz 3.60V 14.91dBm 100% Duty Cycle



Date: 30.JUN.2010 09:05:54

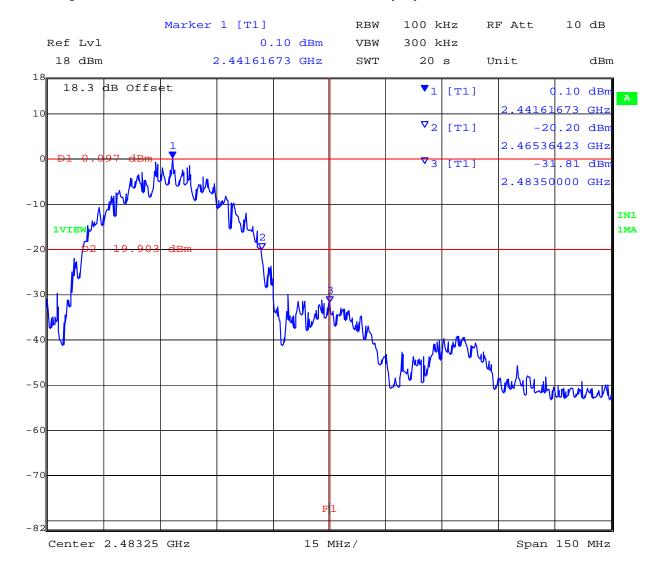


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### Band Edge Ambient 2442MHz 3.60V 14.90dBm 100% Duty Cycle



Date: 30.JUN.2010 09:11:02

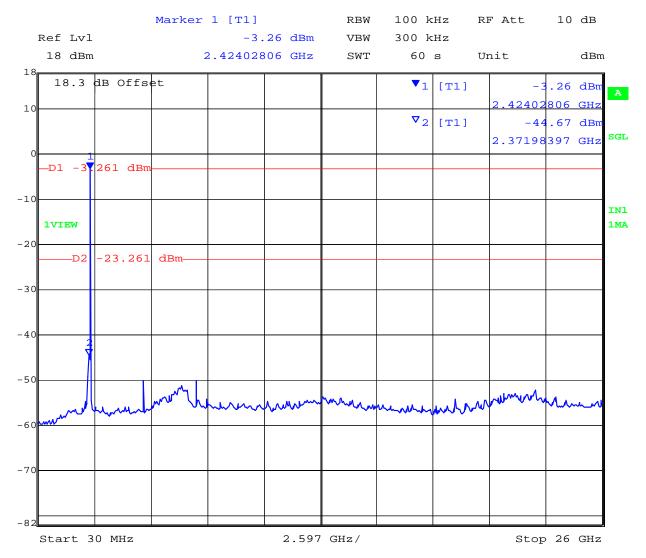


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## 7.5.4 Measurement Results: OOK



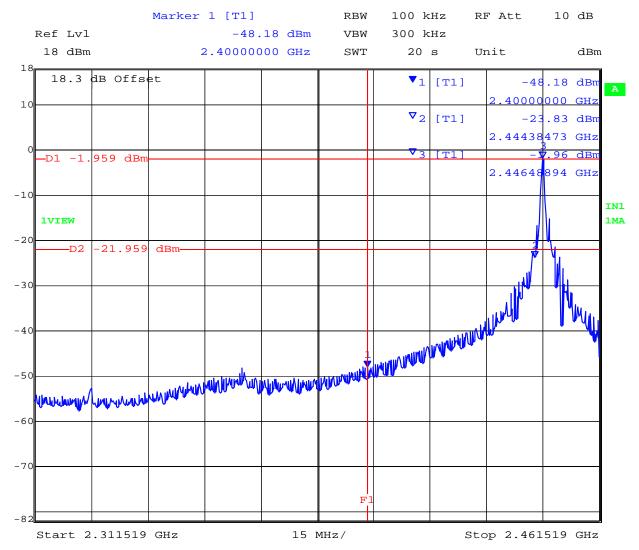


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### Band Edge Ambient 2447MHz 3.60V 1.23dBm 100% Duty Cycle



Date: 30.JUN.2010 09:21:00

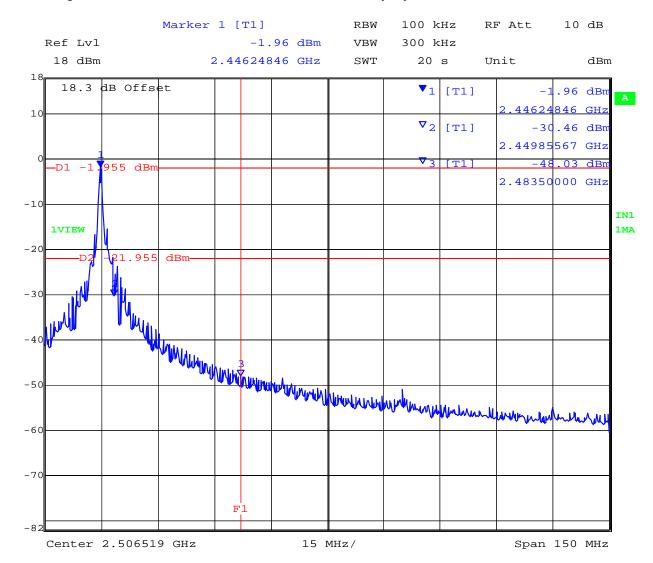


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### Band Edge Ambient 2447MHz 3.60V 1.27dBm 100% Duty Cycle



Date: 30.JUN.2010 09:24:47



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# 7.6 Radiated Spurious Emissions Above 1 GHz - Antenna ZES

#### **Test Procedure**

Testing was performed in a 3-meter anechoic chamber. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. Preliminary emissions were recorded with in Spectrum Analyzer mode, using a maximum peak detector while in peak hold mode.

Emissions nearest the limits were chosen for maximization and formal measurement using a CISPR Compliant receiver. Emissions above 1000 MHz are measured utilizing a CISPR compliant average detector with a tuned receiver, using a bandwidth of 1 MHz. Emissions from 30 MHz – 1000 MHz are measured utilizing a CISPR compliant quasi-peak detector with a tuned receiver, using a bandwidth of 120 kHz. Only the highest emissions relative to the limit are listed.

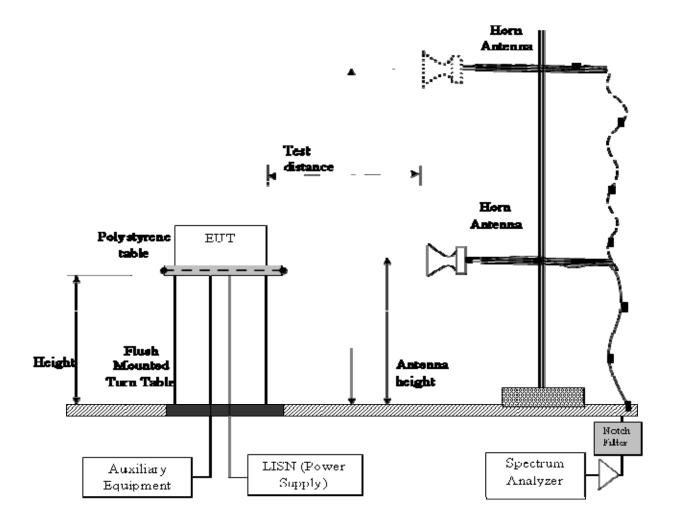


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## **Test Measurement Set Up**



Radiated Emission Measurement Setup - Above 1 GHz



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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

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

#### Field Strength Calculation Example:

Given receiver input reading of 51.5 dB $_{\mu}$ 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:

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

Conversion between  $dB\mu V/m$  (or  $dB\mu V$ ) and  $\mu V/m$  (or  $\mu V$ ) are done as:

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

40 dB $\mu$ V/m = 100  $\mu$ V/m 48 dB $\mu$ V/m = 250  $\mu$ V/m



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### **Specification**

FCC §15.247(d) 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.

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)).

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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**Table 1: FCC 15.209 Spurious Emissions Limits** 

Frequency (MHz)	Field Strength (μV/m)	Field Strength (dBµV/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 Spectrum Measurement** 

Measurement Uncertainty	+5.6/ -4.	5 dB	

Traceability:

Method	Test Equipment Used		
Work instruction WI-03	0088, 0158, 0134, 0304, 0311, 0315, 0310, 0312		



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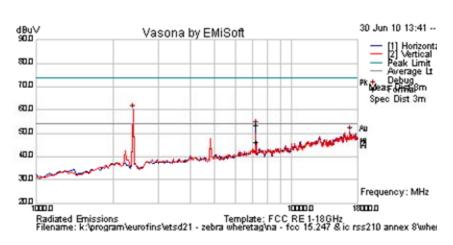
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### 7.6.1 <u>802.11b Radiated Spurious Emissions</u>

Test Freq.	2412 M-1₂	Engineer	GMH					
Variant	802.11b; 1 Mbs	Temp (°C)	27.5					
Freq. Range	1000 M-1z - 18000 M-1z	Rel. Hum.(%)	32					
Power Setting	10 in test utility	Press. (mBars)	1003					
Antenna	ANT=ZES10370	Duty Cycle (%)	3.6 %					
Test Notes 1	undamental attenuated by band-stop filter							
Test Notes 2	BJT tested at 100% duty cycle							





### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
2396.793	68.2	3.0	-11.2	60.0	Peak [Scan]	Н	100	-			NΑ	FUND
7234.909	53.3	5.4	-5.2	53.5	Peak Max	Ι	101	233	74.0	-20.5	Pass	RB
7234.909	45.8	5.4	-5.2	46.0	Average Max	Н	101	233	54	-8.0	Pass	RB



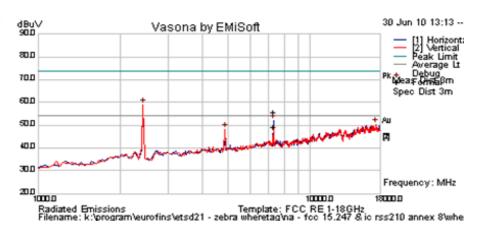
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Test Freq.	2437 MHz	Engineer	GMH
Variant	802.11b; 1 Mbs	Temp (°C)	27.5
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum.(%)	32
Power Setting	10 in test utility	Press. (mBars)	1003
Antenna	ANT=ZES10370	Duty Cycle (%)	3.6 %
Test Notes 1	Fundamental attenuated by band-stop filter		
Test Notes 2	EUT tested at 100% duty cycle		





#### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
2438.0	67.0	3.0	-11.1	59.0	Peak [Scan]	>	100	-	-		N/A	FUND
7309.379	55.0	5.4	-4.9	55.5	Peak Max	Η	103	193	74.0	-18.5	Pass	RB
7309.379	48.5	5.4	-4.9	49.0	Average Max	Η	103	193	54.0	-5.0	Pass	RB
4873.988	53.1	4.5	-9.3	48.3	Peak [Scan]	٧	100	0	54	-5.8	Pass	RB



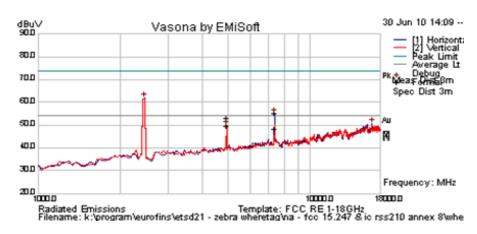
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Test Freq.	2462 MHz	Engineer	GMH					
Variant	802.11b; 1 Mbs	Temp (°C)	27.5					
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum.(%)	32					
Power Setting	10 in test utility	Press. (mBars)	1003					
Antenna	ANT=ZES10370	Duty Cycle (%)	3.6 %					
Test Notes 1	Fundamental attenuated by band-stop filter							
Test Notes 2	EUT tested at 100% duty cycle							





### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
2464.930	69.8	2.980	-11.1	61.720	Peak [Scan]	Τ	100				N/A	FUND
7384.890	54.5	5.5	-4.8	55.1	Peak Max	Ι	99	250	74.0	-18.9	Pass	RB
4923.942	57.5	4.6	-9.1	52.9	Peak Max	>	138	205	74.0	-21.1	Pass	RB
7384.890	47.8	5.5	-4.8	48.4	Average Max	Η	99	250	54	-5.6	Pass	RB
4923.942	54.2	4.6	-9.1	49.7	Average Max	٧	138	205	54	-4.3	Pass	RB



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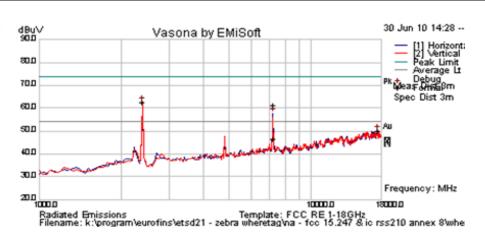
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### 7.6.2 <u>802.11g Radiated Spurious Emissions</u>

Test Freq.	2412 MHz	Engineer	CSB
Variant	802.11g; 6 Mbs	Temp (°C)	27.5
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum.(%)	32
Power Setting	10 in test utility	Press. (mBars)	1003
Antenna	ANT=ZES10370	Duty Cycle (%)	0.72%
Test Notes 1	Fundamental attenuated by band-stop filter		
Test Notes 2	EUT tested at 100% duty cycle		





### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
2396.794	70.9	3.0	-11.2	62.7	Peak [Scan]	>	100				N/A	FUND
7237.610	60.8	5.4	-5.1	61.1	Peak Max	Н	139	39	74.0	-12.9	Pass	RB
7237.61	46.4	5.4	-5.1	46.7	Average Max	Н	139	39	54.0	-7.3	Pass	RB



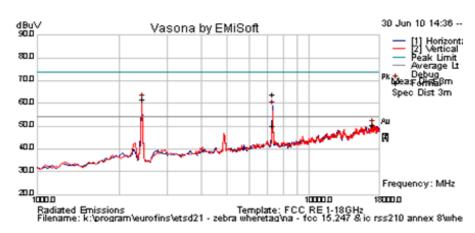
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Test Freq.	2437 MHz	Engineer	CSB					
Variant	802.11g; 6 Mbs	Temp (°C)	27.5					
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum.(%)	32					
Power Setting	10 in test utility	Press. (mBars)	1003					
Antenna	ANT=ZES10370	Duty Cycle (%)	0.72%					
Test Notes 1	undamental attenuated by band-stop filter							
Test Notes 2	EUT tested at 100% duty cycle							





### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
2430.862	69.9	3.0	-11.1	61.7	Peak [Scan]	Η	100	-	-		N/A	FUND
7307.976	63.2	5.4	-4.9	63.7	Peak Max	Н	115	208	74.0	-10.3	Pass	RB
7307.976	49.4	5.4	-4.9	49.9	Average Max	Н	115	208	54.0	-4.1	Pass	RB



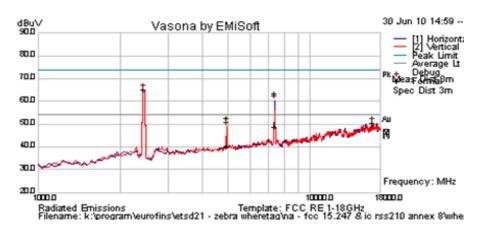
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Test Freq.	2462 MHz	Engineer	CSB					
Variant	802.11g; 6 Mbs	Temp (°C)	27.5					
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum.(%)	32					
Power Setting	10 in test utility	Press. (mBars)	1003					
Antenna	ANT=ZES10370	Duty Cycle (%)	0.72%					
Test Notes 1	undamental attenuated by band-stop filter							
Test Notes 2	EUT tested at 100% duty cycle							





### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
2430.862	73.0	3.0	-11.1	64.9	Peak [Scan]	Н	100	-			N/A	FUND
7386.433	62.8	5.5	-4.8	63.4	Peak Max	Η	101	83	74.0	-10.6	Pass	RB
4923.873	57.0	4.6	-9.1	52.4	Peak Max	Η	181	88	74.0	-21.6	Pass	RB
7386.433	48.1	5.5	-4.8	48.8	Average Max	Η	101	83	54	-5.2	Pass	RB
4923.873	44.6	4.6	-9.1	40.1	Average Max	Н	181	88	54	-14.0	Pass	RB



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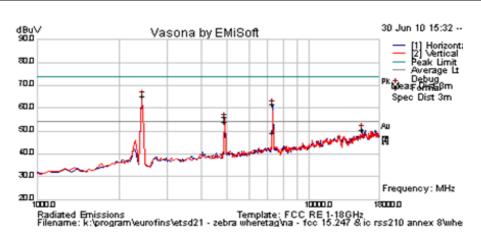
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### 7.6.3 DSSS Radiated Spurious Emissions

Test Freq.	2441.75 MHz	Engineer	CSB
Variant	DSSS	Temp (°C)	27.5
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum.(%)	32
Power Setting	15 in test utility	Press. (mBars)	1003
Antenna	ANT=ZES10370	Duty Cycle (%)	2.55 %
Test Notes 1	EUT was tested at 100% duty cycle.		
Test Notes 2	Fundamental attenuated by band-stop filter		





### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2430.862	73.3	3.0	-11.1	65.2	Peak [Scan]	Н	100	1			N/A	FUND
7325.109	61.2	5.5	-5.1	61.6	Peak Max	Н	101	218	74.0	-12.4	Pass	RB
4883.404	60.7	4.5	-9.3	55.9	Peak Max	V	120	184	74.0	-18.1	Pass	RB
7325.109	49.0	5.5	-5.1	49.3	Average Max	Н	101	218	54	-4.7	Pass	RB
4883.404	58.5	4.5	-9.3	53.7	Average Max	V	120	184	54	-0.3	N/A	RB
4883.404	4883.404 Corrected Value = 21.8					dBuV				-32.2	Pass	RB



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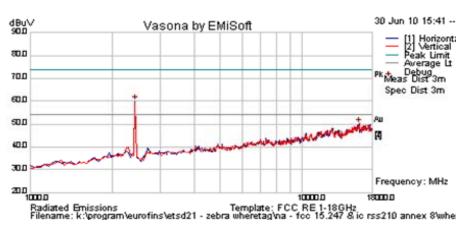
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## 7.6.4 OOK Radiated Spurious Emissions

446.519 MHz	Engineer	CSB					
OK	Temp (°C)	27.5					
000 MHz - 18000 MHz	Rel. Hum.(%)	32					
5 in test utility	Press. (mBars)	1003					
NT=ZES10370	Duty Cycle (%)	13 %					
EUT was tested at 100% duty cycle.							
Fundamental attenuated by band-stop filter							
5 N	DK  00 MHz - 18000 MHz in test utility  IT=ZES10370  IT was tested at 100% duty cycle.	Temp (°C) 00 MHz - 18000 MHz in test utility Press. (mBars) IT=ZES10370 Duty Cycle (%) IT was tested at 100% duty cycle.					





### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
2430.862	68.0	3.0	-11.1	59.9	Peak [Scan]	Н	100				N/A	FUND

Legend:

TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission

RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak



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## 7.6.5 <u>802.11b Radiated Band Edge Emissions</u>

Duty cycle correction factor was applied to spurious emissions in the restricted bands closest to the fundamental transmission.

EUT Operational Duty Cycle: 3.6% Correction Factor = 20 \* LOG (3.6 / 100)

Correction Factor = -28.87dB

Corrected Value = Measured Value (dB) - 28.87 (dB)

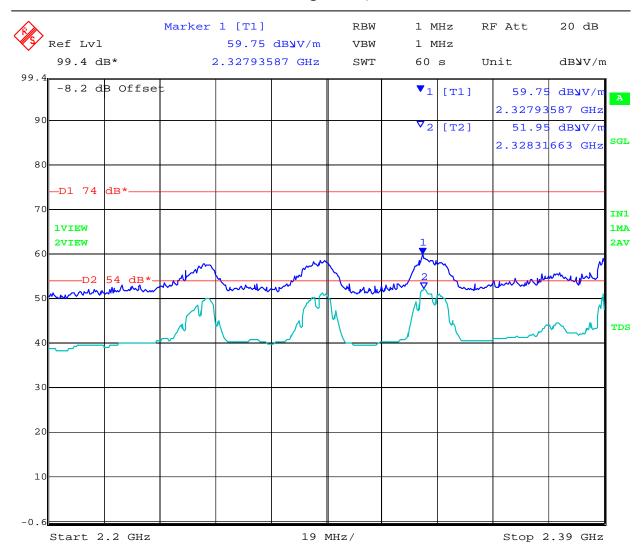
Frequency	Measured	Measurement	Corrected	Margin (dB)	Pass / Fail
(MHz)	Value (dBuV/m)	Туре	Value		
2327.93587	59.75	Peak	30.88	-43.12	Pass
2328.31663	51.95	Average	23.08	-30.92	Pass
2487.93086	73.06	Peak	44.19	-29.81	Pass
2487.69940	69.69	Average	40.82	-13.18	Pass



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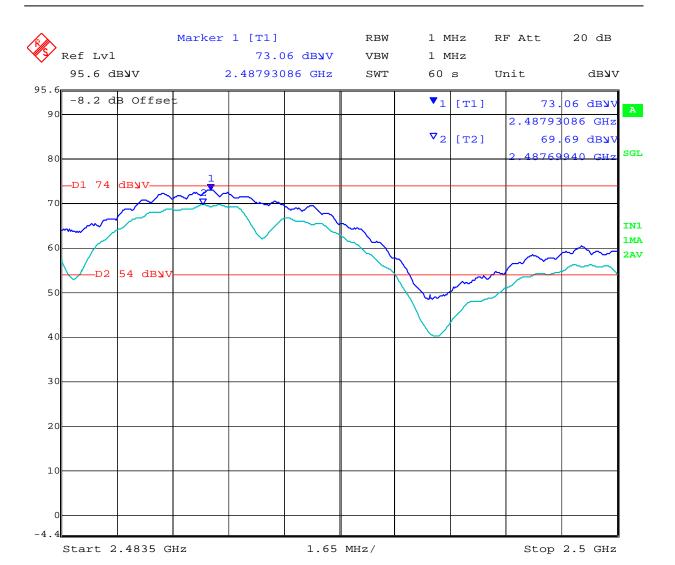




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### 7.6.6 <u>802.11g Radiated Band Edge Emissions</u>

Duty cycle correction factor was applied to spurious emissions in the restricted bands closest to the fundamental transmission.

EUT Operational Duty Cycle: 0.72% Correction Factor = 20 \* LOG (0.72 / 100)

Correction Factor = -42.85dB

Corrected Value = Measured Value (dB) - 42.85 (dB)

Frequency	Measured	Measurement	Corrected	Margin (dB)	Pass / Fail
(MHz)	Value	Туре	Value		
	(dBuV/m)				
2390.00000	83.00	Peak	40.15	-33.85	Pass
2390.00000	66.66	Average	23.81	-30.19	Pass
2483.63226	82.55	Peak	39.70	-34.30	Pass
2483.50000	64.49	Average	21.64	-32.36	Pass



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Date: 1.JUL.2010 18:04:12



2.0

10

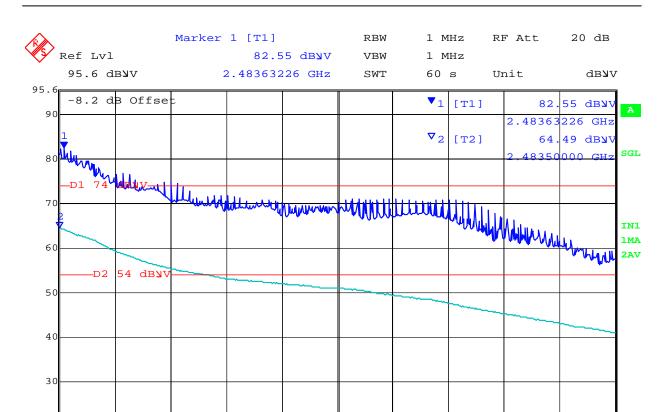
Start 2.4835 GHz

Title: Zebra Enterprise Solutions Corp

WhereTag IV Module

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1.65 MHz/

Stop 2.5 GHz



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### 7.6.7 DSSS Radiated Band Edge Emissions

Duty cycle correction factor was applied to spurious emissions in the restricted bands closest to the fundamental transmission.

EUT Operational Duty Cycle: 2.55% Correction Factor = 20 \* LOG (2.55 / 100)

Correction Factor = -31.87 dB

Corrected Value = Measured Value (dB) - 31.87 (dB)

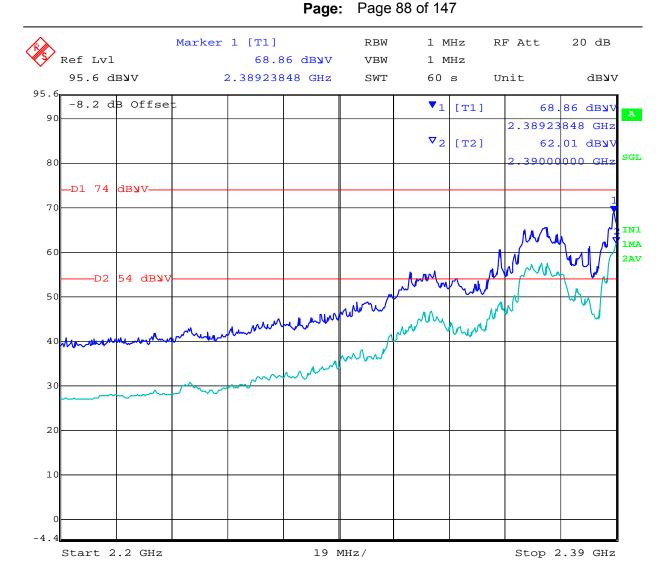
Frequency (MHz)	Measured Value (dBuV/m)	Measurement Type	Corrected Value	Margin (dB)	Pass / Fail
2389.23848	68.86	Peak	36.99	-37.01	Pass
2390.00000	62.01	Average	30.14	-23.86	Pass
2483.50000	75.12	Peak	43.25	-30.75	Pass
2483.50000	66.89	Average	35.02	-18.98	Pass



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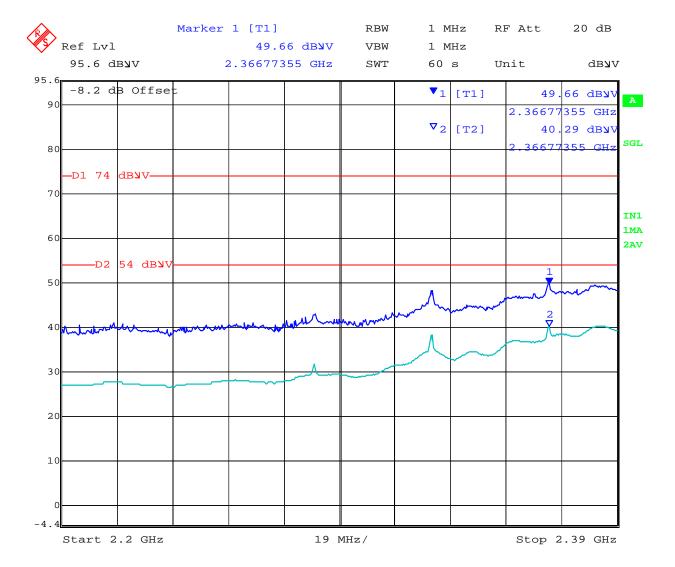
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### 7.6.8 OOK Radiated Band Edge Emissions

All emissions below FCC limits when tested at 100% duty cycle. No duty cycle correction factor required to comply with FCC limits.





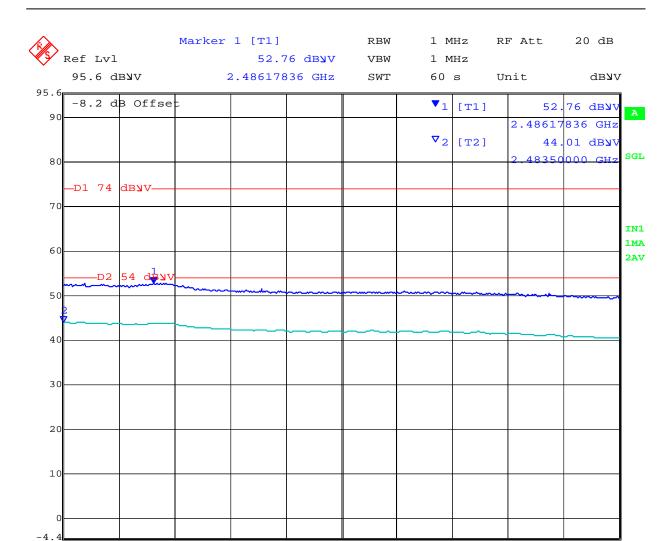
Start 2.4835 GHz

Title: Zebra Enterprise Solutions Corp

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1.65 MHz/

Stop 2.5 GHz



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### 7.6.9 802.11b RSS-210 Radiated Peak Emissions

Test Freq. 2412 MHz  Variant 802.11b; 1 Mbs  Freq. Range 2400 - 2483.5 MHz  Power Setting 10 in test utility software  Antenna ANT=ZES10370  Test Notes 1  Test Notes 2  MiccMLabs  ABUVIT  Vasona by EMiSoft  O1 Jul 10 13:17  Fill Herizont:  Debug  Meas Dist 3m Spec Dist 3m Sp											,		
Frequency Raw Hard British Rel. Hum. (%) 36  Power Setting 10 in test utility software Press. (mBars) 1001  Antenna ANT=ZES10370 Duty Cycle (%) 100  Test Notes 1  Test Notes 2  MiCOMLabs  deuvin Vasona by EMISoft 01 Jul 10 13:17	Tes	t Freq.	2412 M	Hz						Engineer	SB		
Power Setting 10 in test utility software  Antenna ANT=ZES10370  Duty Cycle (%) 100  Test Notes 1  Test Notes 2  MiCOVLabs  dBu\/m  Vasona by EMiSoft  01 Jul 10 13:17  [1] Horizont: H. Linit Debug  Meas Dist 3m Spec Dist 3m	١	Variant	802.11	o; 1 Mbs					Т	emp (ºC)	28		
Antenna ANT=ZES10370 Duty Cycle (%) 100  Test Notes 1  Test Notes 2  MiCOM Labs  dBut/m Vasona by EMiSoft 01 Jul 10 13:17 115.0	Freq.	Range	2400 - 2	2483.5 N	ИHz				Rel.	Hum.(%)	36		
Test Notes 1  Test Notes 2  MiCOMLabs  dBuV/m Vasona by EMiSoft  01 Jul 10 13:17  1155  1101  Was Dist 3m Spec Dist 3m Frequency: MHz  24315  Frequency: MHz	Power S	Setting	10 in te	st utility	software				Press.	. (mBars)	1001		
Test Notes 2  MicoMLabs  dBuv/m Vasona by EMiSoft  110	Aı	ntenna	ANT=Z	ES1037	0				Duty	Cycle (%)	100		
Meas Dist 3m Spec	Test N	lotes 1									-		
Formally measured emission peaks  Frequency Raw dBuV Loss AF dB dBuV/m Type Pol Hgt Azt Limit Margin dBuV/m Measurement dBuV/m Type Pol Cm Deg dBuV/m Margin dBuV/m Deg dBuV/m Deg dBuV/m Washington Comments  TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission	Test N	lotes 2											
Frequency MHz Cable Loss AF dB Level dBuV/m Type Pol cm Deg dBuV/m Margin dB Pass /Fail Comments  2413.221 66.5 7.1 30.4 104.1 Peak [Scan] V  Legend: TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission	MiC®M	abs	1100 1000 1000 960 960		nissions W	Where Tag	Meas Speci Frequence	] Horizon k Lmt k Lmt ebug Dist 3m Dist 3m cy: MHz	it:				
MHz dBuV Loss AF dB dBuV/m Type Pol cm Deg dBuV/m dB /Fail Comments  2413.221 66.5 7.1 30.4 104.1 Peak [Scan] V  Legend: TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission	Formally	meas	ured e	ed emission peaks									
Legend: TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission	Frequency MHz			AF dB			Pol	_			_		Comments
· ·	2413.221	66.5	7.1	30.4	104.1	Peak [Scan]	V						
PK = Peak emissions of Fundamental	Legend:	TX = T	ransmitt	er Emis	sions; DIG	= Digital Emission	ns; FL	IND = F	undan	nental; WB	B = Wideba	and Emi	ssion
	-	PK = F	eak emi	issions o	of Fundame	ental							



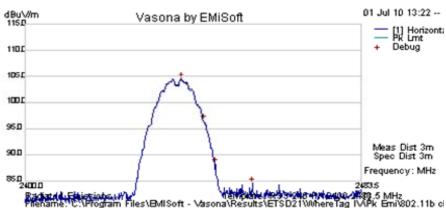
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-			
Test Freq.	2437 MHz	Engineer	SB
Variant	802.11b; 1 Mbs	Temp (°C)	28
Freq. Range	2400 - 2483.5 MHz	Rel. Hum.(%)	36
Power Setting	10 in test utility software	Press. (mBars)	1001
Antenna	ANT=ZES10370	Duty Cycle (%)	100
Test Notes 1			
Test Notes 2			
MiCeMLahs	40.4%		01 14 10 12:22





# Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2438.549	67.0	7.1	30.5	104.7	Peak [Scan]	V						

Legend:

TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission

PK = Peak emissions of Fundamental



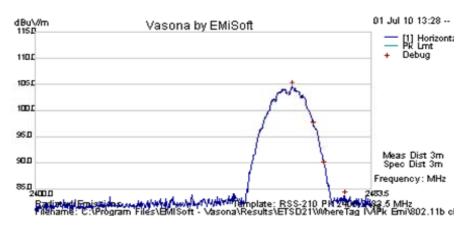
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=			
Test Freq.	2462 MHz	Engineer	SB
Variant	802.11b; 1 Mbs	Temp (°C)	28
Freq. Range	2400 - 2483.5 MHz	Rel. Hum.(%)	36
Power Setting	10 in test utility software	Press. (mBars)	1001
Antenna	ANT=ZES10370	Duty Cycle (%)	100
Test Notes 1			
Test Notes 2			





#### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2463.738	66.9	7.2	30.6	104.6	Peak [Scan]	٧						_

Legend: TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
PK = Peak emissions of Fundamental



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## 7.6.10 802.11g RSS-210 Radiated Peak Emissions

PK = Peak emissions of Fundamental

Test	Freq.	2412 M	Hz						Engineer	SB			
Va	ariant	802.110	.11g; 6 Mbs <b>Temp (</b> 9										
Freq. R	Range	2400 - 2	00 - 2483.5 MHz Rel. Hum.(%								36		
Power Se	etting	10 in te	st utility	software				Press.	(mBars)	1001			
Ant	tenna	ANT=Z	ES1037	0				Duty	Cycle (%)	100			
Test No	otes 1												
Test No	otes 2												
MiC@MLa			diated En		Vasona by E			146 21V		Meas Spec I Frequence	) Horizon ( Lmt Ebug Dist 3m Dist 3m Dy: MHz	ti	
	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments	
2406.123	70.4	7.1	30.4	107.9	Peak [Scan]	V							
Legend:	TX = T	ransmitt	nsmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission										



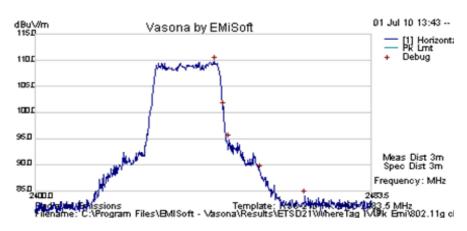
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Test Freq.	2437 MHz	Engineer	SB
Variant	802.11g; 6 Mbs	Temp (°C)	28
Freq. Range	2400 - 2483.5 MHz	Rel. Hum.(%)	36
Power Setting	10 in test utility software	Press. (mBars)	1001
Antenna	ANT=ZES10370	Duty Cycle (%)	100
Test Notes 1			
Test Notes 2			





### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2444.255	72.2	7.2	30.5	109.9	Peak [Scan]	٧						

Legend: TX

TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission

PK = Peak emissions of Fundamental



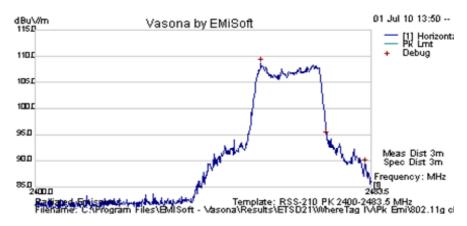
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Test Freq.	2462 MHz	Engineer	SB
Variant	802.11g; 6 Mbs	Temp (°C)	28
Freq. Range	2400 - 2483.5 MHz	Rel. Hum.(%)	36
Power Setting	10 in test utility software	Press. (mBars)	1001
Antenna	ANT=ZES10370	Duty Cycle (%)	100
Test Notes 1			
Test Notes 2			





### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2455.806	71.0	7.2	30.6	108.7	Peak [Scan]	V						<u> </u>

Legend: TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
PK = Peak emissions of Fundamental



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## 7.6.11 DSSS RSS-210 Radiated Peak Emissions

Tes	t Freq.	2441.75	5 MHz						Engineer	SB		
\	/ariant	DSSS						T	emp (°C)	28		
Freq.	Range	2400 - 2	2483.5 N	ИHz				Rel.	Hum.(%)	36		
Power S	Setting	14 in te	st utility	software				Press	. (mBars)	1001		
Ar	ntenna	ANT=Z	ES1037	0				Duty	Cycle (%)	100		
Test N	lotes 1				•					-		
Test N	lotes 2											
MiC®M			p hame: C		Vasona by E	νt <sub>νν</sub>	mit	A A A A A A A A A A A A A A A A A A A	Where Tag	+ D	] Horizon K Lmit Lmit Ebug Dist 3m Dist 3m Cy: MHz	it:
rormally	measi	urea e	red emission peaks									
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2442.168	70.7	7.2	30.5	108.4	Peak [Scan]	V						PK
Legend:	TX = T	ransmitt	ansmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission									
			k emissions of Fundamental									



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## 7.6.12 OOK RSS-210 Radiated Peak Emissions

		1											
Tes	t Freq.	2446.51	19 MHz						Engineer	SB			
\	/ariant	OOK						T	emp (°C)	28			
Freq.	Range	2400 - 2	2483.5 N	ИHz				Rel.	Hum.(%)	36			
Power S	Setting	Maximu	ım					Press	. (mBars)	1001			
Ar	ntenna	ANT=ZI	ES1037	0				Duty	Cycle (%)	100			
Test N	lotes 1									-			
Test N	lotes 2												
MiC@M	abs	0Bu\/m 115.0 110.0 105.0 100.0 95.0 96.0 96.0 96.0 96.0 96.0 96.0 96.0 96		\Program F	Vasona by E		in the second	1550211	Where Tag	Meas Spec Frequence	] Horizon K Lmt Lmt ebug Dist 3m Dist 3m cy: MHz	it:	
Formally	meas	ured e	ed emission peaks										
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments	
2447.038	73.9	7.2	30.5	111.5	Peak [Scan]	V						PK	
Legend:	TX = T	ransmitt	nsmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission										
	Di/ D		c emissions of Fundamental										



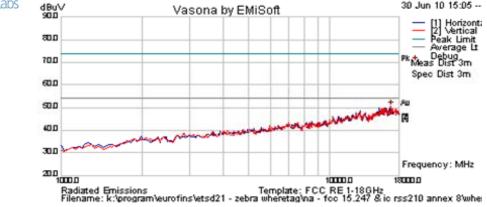
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### 7.6.13 RSS-210 Receiver Radiated Emissions

Test Freq.	2446.519 MHz	Engineer	CSB
Variant	ООК	Temp (°C)	27.5
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum.(%)	32
Power Setting	Not Applicable in Receive Mode	Press. (mBars)	1003
Antenna	ANT=ZES10370		
Test Notes 1	EUT was tested at 100% duty cycle.		
Test Notes 2			
<b>Mic©iM</b> Labs	dBu∨ Vasona by E	MiSoft	30 Jun 10 15:05  [1] Horizont:  [2] Vertical  Peak Limit  Average Lt  Debug



### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
No Receiver E	mission	s within	6dB of li	mit.								
16841.683	40.2	8.6	1.8	50.5	Peak [Scan]	V	100	0	54.0	-3.5	Pass	Noise

Legend: TRANS = Transient Emission; RB = Restricted Band; NRB = Non-Restricted Band;
BE = Emission in Restricted Band Nearest Transmission Band Edge; FUND = Fundamental Freq.



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## 7.7 Radiated Spurious Emissions above 1 GHz - Antenna Taoglas

#### **Test Procedure**

Testing was performed in a 3-meter anechoic chamber. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. Preliminary emissions were recorded with in Spectrum Analyzer mode, using a maximum peak detector while in peak hold mode.

Emissions nearest the limits were chosen for maximization and formal measurement using a CISPR Compliant receiver. Emissions above 1000 MHz are measured utilizing a CISPR compliant average detector with a tuned receiver, using a bandwidth of 1 MHz. Emissions from 30 MHz – 1000 MHz are measured utilizing a CISPR compliant quasi-peak detector with a tuned receiver, using a bandwidth of 120 kHz. Only the highest emissions relative to the limit are listed.

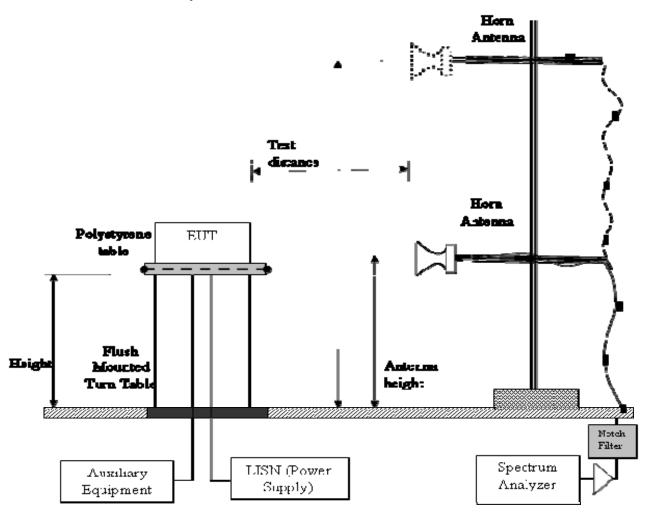


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### **Test Measurement Set Up**



Radiated Emission Measurement Setup – Above 1 GHz



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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

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

#### Field Strength Calculation Example:

Given receiver input reading of 51.5 dB $_{\mu}$ 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:

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

Conversion between  $dB\mu V/m$  (or  $dB\mu V$ ) and  $\mu V/m$  (or  $\mu V$ ) are done as:

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

40 dB $\mu$ V/m = 100  $\mu$ V/m 48 dB $\mu$ V/m = 250  $\mu$ V/m



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### **Specification**

FCC §15.247(d) 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.

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)).

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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**Table 1: FCC 15.209 Spurious Emissions Limits** 

Frequency (MHz)	Field Strength (µV/m)	Field Strength (dBµV/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 Spectrum Measurement** 

	<u> </u>	
	. E 0/ 4 E ID	
Measurement Uncertainty	1 +5 6/ -4 5 dB	
i wicasarciniciti Officertainty	+3.0/ -4.3 UD	

Traceability:

Method	Test Equipment Used
Work instruction WI-03	0088, 0158, 0134, 0304, 0311, 0315, 0310, 0312



WhereTag IV Module

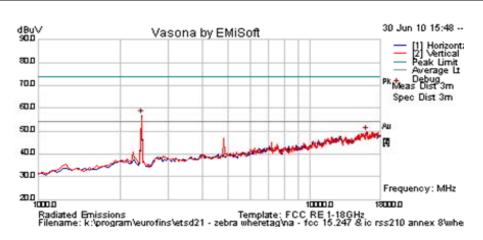
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### 7.7.1 802.11b Radiated Spurious Emissions

Test Freq.	2412 MHz	Engineer	GMH					
Variant	802.11b; 1 Mbs	Temp (°C)	27.5					
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum.(%)	32					
Power Setting	10 in test utility	Press. (mBars)	1003					
Antenna	ANT=Taoglas	3.6 %						
Test Notes 1	Fundamental attenuated by band-stop filter							
Test Notes 2	EUT tested at 100% duty cycle							





## Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
2396.794	65.0	3.0	-11.2	56.8	Peak [Scan]	Н	100				N/A	FUND

Legend:

TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission

RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak



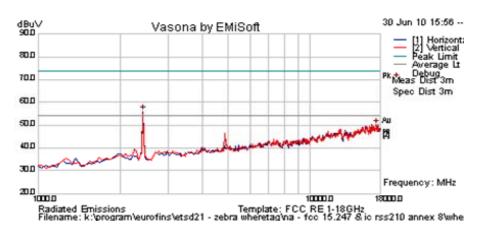
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Test Freq.	2437 MHz	Engineer	GMH					
Variant	802.11b; 1 Mbs	Temp (°C)	27.5					
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum.(%)	32					
Power Setting	10 in test utility	Press. (mBars)	1003					
Antenna	ANT=Taoglas	3.6 %						
Test Notes 1	Fundamental attenuated by band-stop filter							
Test Notes 2	EUT tested at 100% duty cycle							





### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
2430.862	64.1	3.0	-11.1	55.9	Peak [Scan]	Н	100				N/A	FUND



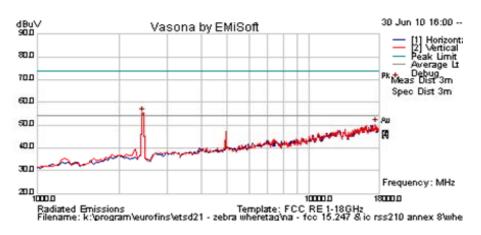
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Test Freq.	2462 MHz	Engineer	GMH					
•								
variant	802.11b; 1 Mbs	Temp (°C)	21.5					
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum.(%)	32					
Power Setting	10 in test utility	Press. (mBars)	1003					
Antenna	ANT=Taoglas	3.6 %						
Test Notes 1	Fundamental attenuated by band-stop filter							
Test Notes 2	EUT tested at 100% duty cycle							





### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
2430.862	63.4	3.0	-11.1	55.3	Peak [Scan]	٧	100	-			N/A	Fund

Legend:

TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission

RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak



WhereTag IV Module

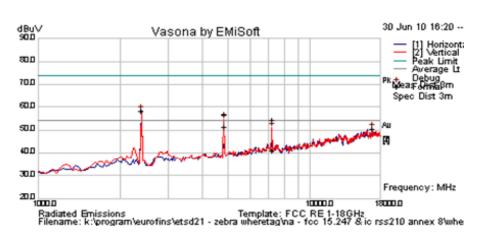
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## 7.7.2 <u>802.11g Radiated Spurious Emissions</u>

Test Freq.	2412 MHz	Engineer	GMH				
Variant	802.11g; 6 Mbs	Temp (°C)	27.5				
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum.(%)	32				
Power Setting	10 in test utility	Press. (mBars)	1003				
Antenna	ANT=Taoglas	Duty Cycle (%)	0.72				
Test Notes 1	Fundamental attenuated by band-stop filter						
Test Notes 2	EUT tested at 100% duty cycle						





#### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
2396.794	66.4	3.0	-11.2	58.2	Peak [Scan]	Ι	100	1	1	1	N/A	FUND
4823.983	61.9	4.5	-9.4	57.0	Peak Max	<b>V</b>	137	222	74.0	-17.1	Pass	RB
7235.07	53.9	5.4	-5.2	54.2	Peak Max	V	98	300	74.0	-19.9	Pass	RB
4823.983	56.4	4.5	-9.4	51.5	Average Max	V	137	222	54	-2.5	Pass	RB
7235.070	41.0	5.4	-5.2	41.2	Average Max	V	98	300	54	-12.8	Pass	RB



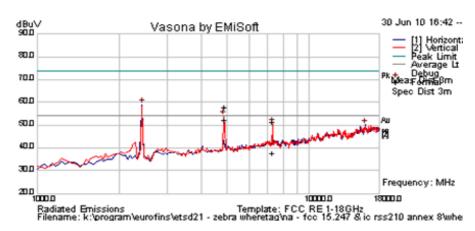
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Test Freq.	2437 MHz	Engineer	GMH				
Variant	802.11g; 6 Mbs	Temp (°C)	27.5				
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum.(%)	32				
Power Setting	10 in test utility	Press. (mBars)	1003				
Antenna	ANT=Taoglas	Duty Cycle (%)	0.72				
Test Notes 1	Fundamental attenuated by band-stop filter						
Test Notes 2	EUT tested at 100% duty cycle						





#### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
2430.862	67.1	3.0	-11.1	59.0	Peak [Scan]	Η	100				N/A	FUND
4873.952	62.8	4.5	-9.3	57.9	Peak Max	٧	148	326	74.0	-16.1	Pass	RB
7310.371	51.0	5.4	-4.9	51.5	Peak Max	٧	99	282	74.0	-22.5	Pass	RB
4873.952	57.2	4.5	-9.3	52.4	Average Max	٧	148	326	54	-1.7	Pass	RB
7310.371	37.0	5.4	-4.9	37.6	Average Max	V	99	282	54	-16.4	Pass	RB



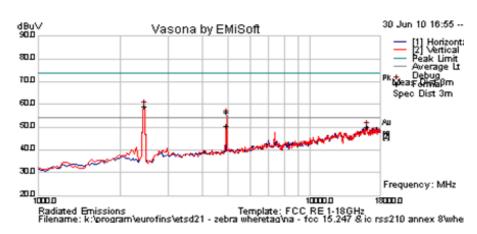
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Test Freq.	2462 MHz	Engineer	GMH				
Variant	802.11g; 6 Mbs	Temp (°C)	27.5				
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum.(%)	32				
Power Setting	10 in test utility	Press. (mBars)	1003				
Antenna	ANT=Taoglas	Duty Cycle (%)	0.72				
Test Notes 1	Fundamental attenuated by band-stop filter						
Test Notes 2	EUT tested at 100% duty cycle						





#### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
2464.930	67.1	3.0	-11.1	59.0	Peak [Scan]	٧	100	-	-	-	N/A	FUND
4923.925	61.0	4.6	-9.1	56.4	Peak Max	V	101	132	74.0	-17.6	Pass	RB
4923.925	55.0	4.6	-9.1	50.5	Average Max	V	101	132	54.0	-3.5	Pass	RB



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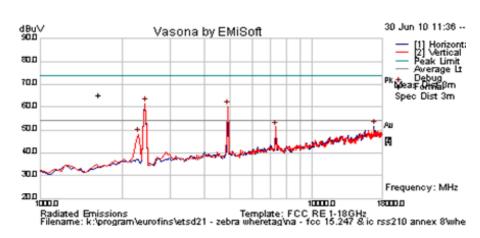
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## 7.7.3 <u>DSSS Radiated Spurious Emissions</u>

Test Freq.	2412 MHz	Engineer	CSB					
Variant	802.11n; HT-20; 6.5 MCS	Temp (°C)	27.5					
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum.(%)	32					
Power Setting	15 in test utility	Press. (mBars)	1003					
Antenna	ANT=Taoglas	Duty Cycle (%)	2.55 %					
Test Notes 1	UT was tested at 100% duty cycle. Correction factor added to peak measurements.							
Test Notes 2	Fundamental attenuated by band-stop filter							





#### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
2441.733	69.6	3.0	-11.0	61.5	Peak [Scan]	>	100				N/A	FUND
4883.437	65.1	4.5	-9.3	60.3	Peak [Scan]	<b>V</b>	100	0	54	6.3	N/A	RB
4883.437	Co	orrected	Value =	28.4	dBuV				54.0	-25.6	Pass	RB
7325.130	51.0	5.5	-5.1	51.4	Peak [Scan]	V	100	0	54	-2.6	Pass	RB
7325.130	Co	orrected	Value =	19.5	dBuV				54.0	-34.5	Pass	RB



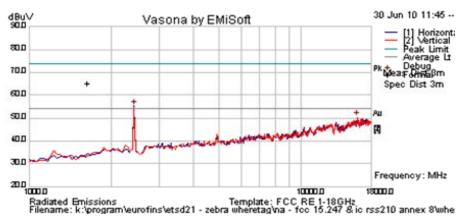
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# 7.7.4 OOK Radiated Spurious Emissions

Test Freq.	2446.519 MHz	Engineer	CSB
Variant		Temp (°C)	27.5
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum.(%)	32
Power Setting	15 in test utility	Press. (mBars)	1003
Antenna	ANT=Taoglas	Duty Cycle (%)	13 %
Test Notes 1	EUT was tested at 100% duty cycle. Correct	tion factor added to peak meas	urements.
Test Notes 2	Fundamental attenuated by band-stop filter		
<b>MiC®M</b> Labs	dBu∨ Vasona by E	MiSoft	30 Jun 10 11:45  [1] Horizont:  [2] Vertical  Peak Limit  Average Lt



# Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
2446.373	63.4	3.0	-11.0	55.4	Peak [Scan]	Н	100				N/A	FUND



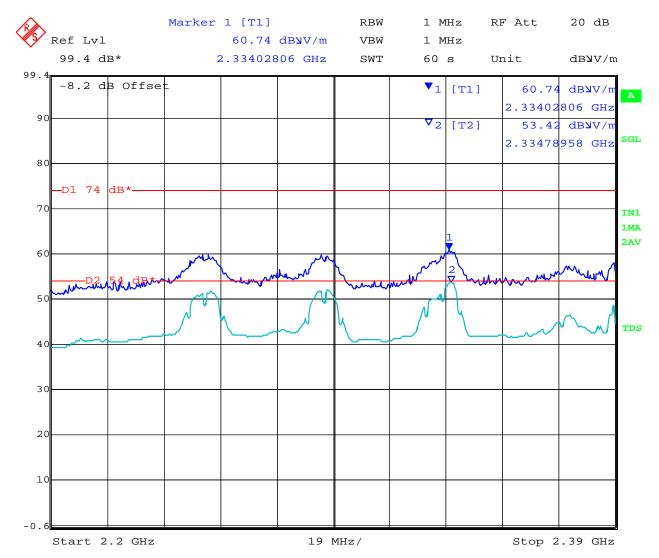
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## 7.7.5 <u>802.11b Radiated Band Edge Emissions</u>

All emissions below FCC limits when tested at 100% duty cycle. No duty cycle correction factor required to comply with FCC limits.



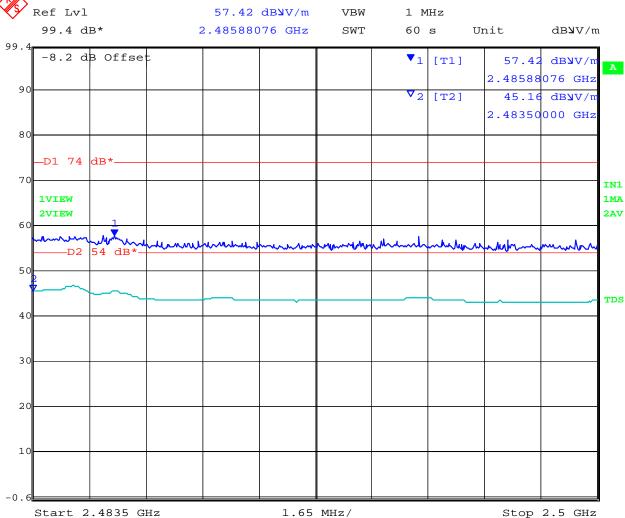


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Marker 1 [T1] RBW 1 MHz RF Att 20 dB



Date: 1.JUL.2010 18:18:32



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## 7.7.6 <u>802.11g Radiated Band Edge Emissions</u>

Duty cycle correction factor was applied to spurious emissions in the restricted bands closest to the fundamental transmission.

EUT Operational Duty Cycle: 0.72% Correction Factor = 20 \* LOG (0.72 / 100)

Correction Factor = -42.85dB

Corrected Value = Measured Value (dB) - 42.85 (dB)

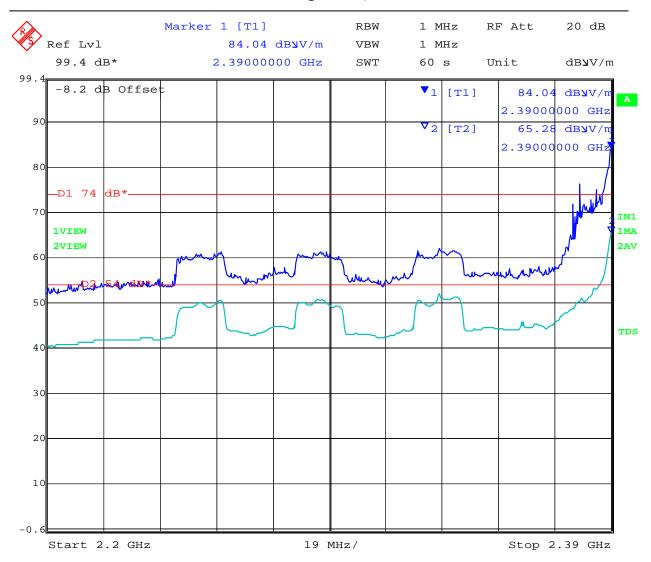
Frequency	Measured	Measurement	Corrected	Margin (dB)	Pass / Fail
(MHz)	Value	Туре	Value		
	(dBuV/m)				
2390	84.04	Peak	41.1866	-32.8134	Pass
2390	65.28	Average	22.4266	-31.5734	Pass
2483.632	83.51	Peak	40.6566	-33.3434	Pass
2483.5	63.98	Average	21.1266	-32.8734	Pass



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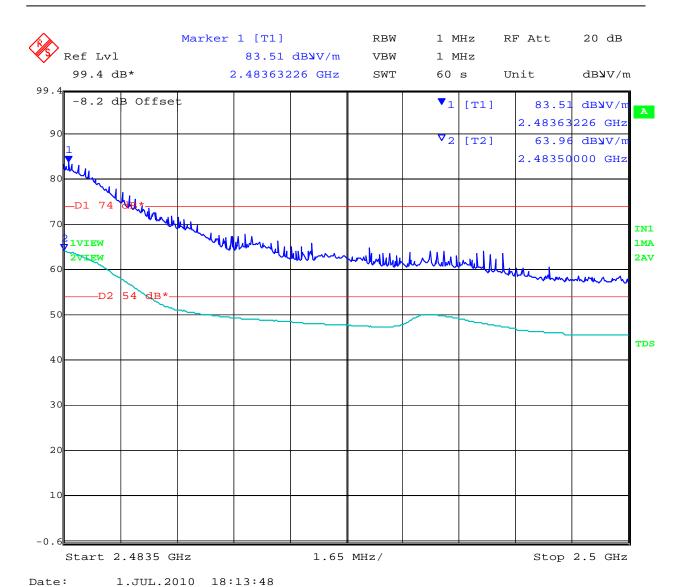
Date: 1.JUL.2010 17:41:28



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## 7.7.7 <u>DSSS Radiated Band Edge Emissions</u>

Duty cycle correction factor was applied to spurious emissions in the restricted bands closest to the fundamental transmission.

EUT Operational Duty Cycle: 2.55% Correction Factor = 20 \* LOG (2.55 / 100)

Correction Factor = -31.87 dB

Corrected Value = Measured Value (dB) - 31.87 (dB)

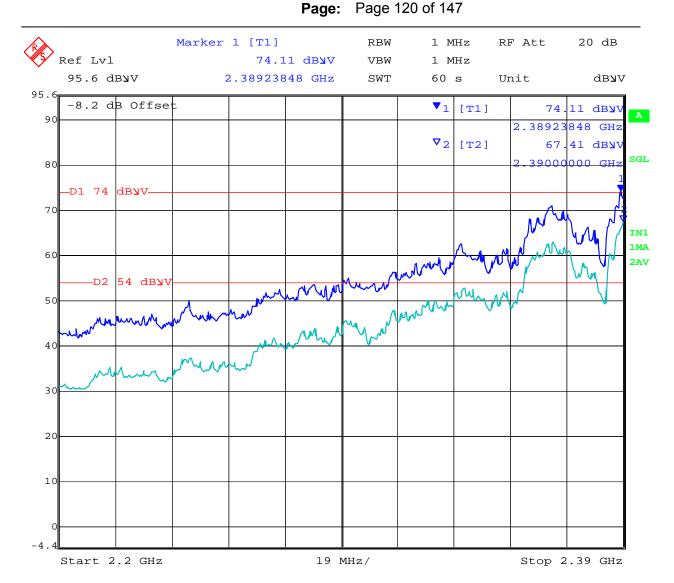
Frequency (MHz)	Measured Value (dBuV/m)	Measurement Type	Corrected Value	Margin (dB)	Pass / Fail
2389.238	74.11	Peak	42.24	-31.76	Pass
2390	67.41	Average	35.54	-18.46	Pass
2483.5	75.78	Peak	43.91	-30.09	Pass
2486.641	67.99	Average	36.12	-17.88	Pass



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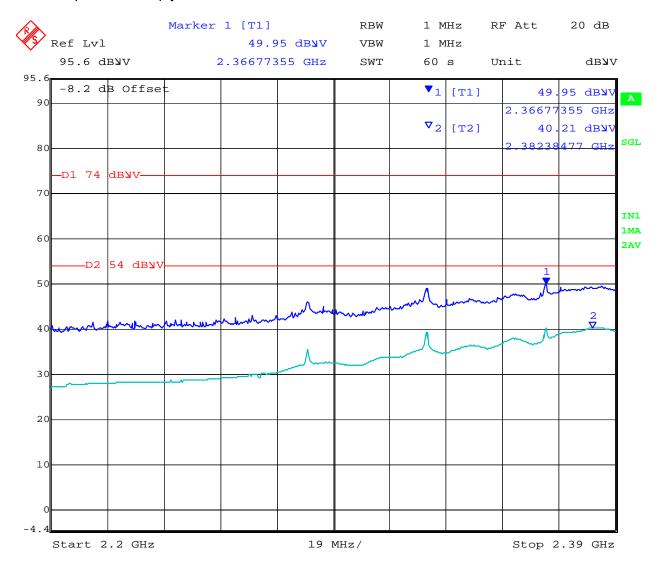
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## 7.7.8 OOK Radiated Band Edge Emissions

All emissions below FCC limits when tested at 100% duty cycle. No duty cycle correction factor required to comply with FCC limits.



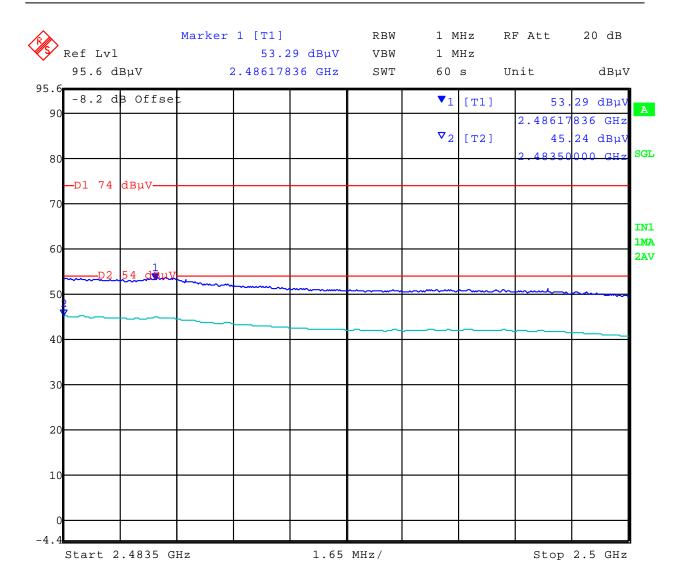


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# 7.7.9 802.11b Radiated Peak Emissions

Test	t Freq.	2412 M	Hz						Engineer	CSB			
V	/ariant	802.11b	o; 1 Mbs					Т	emp (°C)	28			
Freq.	Range	2400 - 2	2483.5 N	ИHz				Rel.	Hum.(%)	36			
Power S	Setting	10 in te	st utility	software				Press.	(mBars)	1001			
Ar	ntenna	ANT=Ta	aoglas					Duty	Cycle (%)	100			
Test N	lotes 1												
Test N	lotes 2												
MiCeM	abs	dBuV/m Vasona by EMiSoft  1100  1100  1000  1000  Meas Dist 3m Spec Dist 3m Frequency: MHz  2433.5  Padiated Emissions  Padiated Emiss											
Formally	meas	ured e	emissi	on peal	ks								
Frequency MHz	Raw dBuV	Cable Loss AF dB Level dBuV/m Measurement Type Pol Hgt Azt Deg dBuV/m Margin dB Pass Comments											
2413.360	67.4	7.1 30.4 104.9 Peak [Scan] V PK											
		ansmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission											
Legend:	TX = T	ransmitt	er Emis	sions; DIG	= Digital Emission	ns; FL	IND = F	undan	nental; WB	s = Wideb	and Emi	ssion	



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		1										
Tes	t Freq.	2437 M	Hz						Engineer	CSB		
\	/ariant	802.11b	; 1 Mbs					T	emp (°C)	28		
Freq.	Range	2400 - 2	2483.5 N	ИHz				Rel.	Hum.(%)	36		
Power S	Setting	10 in te	st utility	software				Press	. (mBars)	1001		
Ar	ntenna	ANT=T	aoglas					Duty	Cycle (%)	100		
Test N	lotes 1											
Test N	lotes 2											
	MiccMLabs  dBuV/m Vasona by EMiSoft  1101  1101  1101  1001  950  Meas Dist 3m Spec Dist 3m Spec Dist 3m Spec Dist 3m Frequency: MHz  24000  24000  Balting Birshold Birshold BullSoft - Vasona\Results\ETSD21\Where Tag IVIPk Emi\802.11b cl											
Frequency	Raw	Cable	missic	Level	Measurement		Hat	Azt	Limit	Margin	Pass	
MHz	dBuV	Loss	AF dB	dBuV/m	Type	Pol	Hgt cm	Deg	dBuV/m	dB	/Fail	Comments
2438.688	67.0	7.1	30.5	104.7	Peak [Scan]	V						PK
Legend:	TX = T	ransmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission										
Legena. I	171			, -	J	,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	undun	iciitai, vv			



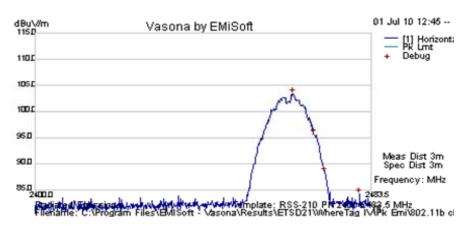
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Test Freq.	2462 MHz	Engineer	CSB
Variant	802.11b; 1 Mbs	Temp (°C)	28
Freq. Range	2400 - 2483.5 MHz	Rel. Hum.(%)	36
Power Setting	10 in test utility software	Press. (mBars)	1001
Antenna	ANT=Taoglas	Duty Cycle (%)	100
Test Notes 1			
Test Notes 2			





#### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2463.878	65.5	7.2	30.6	103.3	Peak [Scan]	V						PK

Legend:

TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission



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# 7.7.10 802.11g Radiated Peak Emissions

Freq. Rar Power Sett Anter Test Note	riant 8 inge 2 iting 1 inna A es 1 es 2	2400 - 2 10 in tes ANT=Ta	; 6 Mbs 2483.5 M st utility		Vasona by E	MiSof		Rel. Press.	emp (°C)	01 Jul 10	Horizon			
Freq. Rar Power Sett Anter Test Note	enna Aes 1 es 2	2400 - 2 10 in tes ANT=Ta	2483.5 M st utility	ИНz	Vasona by E	MiSof		Rel. Press.	Hum.(%) (mBars)	36 1001 100 01 Jul 10	Horizon			
Power Sett  Anter  Test Note  Test Note	enna Aes 1 es 2	10 in tes 10 in tes 10 in tes 10 in tes	st utility		Vasona by E	MiSoff		Press.	(mBars)	1001 100	Horizon			
Anter Test Note Test Note	enna Aes 1 es 2	1101 1051		software	Vasona by E	MiSof			-	01 Jul 10	Horizon			
Test Note	es 1 es 2	18u\/m 115.D 110.C 105.C	aoglas	ستسم	Vasona by E	MiSof	ì	Duty	Cycle (%)	01 Jul 10	Horizon			
Test Note	es 2	115.D 110.C 105.C	Mar	نتم	Vasona by E	MiSof	t			= [1]	Horizon			
	OS d	115.D 110.C 105.C	<u></u>	شم	Vasona by E	MiSof	t			= [1]	Horizon			
<b>Mic©M</b> Lab	100	115.D 110.C 105.C	m	itan	Vasona by E	MiSof	t			= [1]	Horizon			
110C — [1] Horizont:  — Pk Lmt  + Debug														
Formally me			emissi	ion peal	<u> </u>									
		I AF dRI I Poll I I I I Comments I												
2414.195 69	69.9	7.1	30.4	9.9 7.1 30.4 107.4 Peak [Scan] V										
Legend: TX	X = Tra	ransmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission												



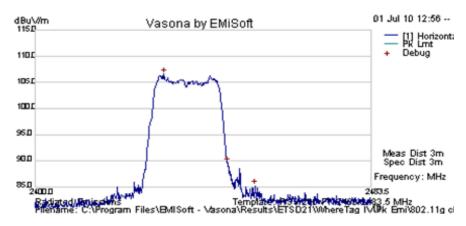
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Test Freq.	2437 MHz	Engineer	CSB
Variant	802.11g; 6 Mbs	Temp (°C)	28
Freq. Range	2400 - 2483.5 MHz	Rel. Hum.(%)	36
Power Setting	10 in test utility software	Press. (mBars)	1001
Antenna	ANT=Taoglas	Duty Cycle (%)	100
Test Notes 1			
Test Notes 2			





# Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2431.730	69.0	7.1	30.5	106.6	Peak [Scan]	V						PK

Legend:

TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission



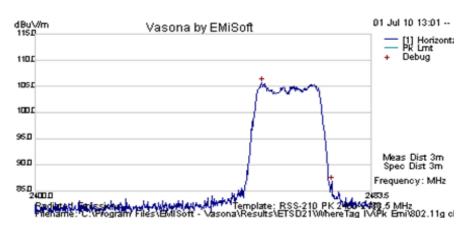
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P			
Test Freq.	2462 MHz	Engineer	CSB
Variant	802.11g; 6 Mbs	Temp (°C)	28
Freq. Range	2400 - 2483.5 MHz	Rel. Hum.(%)	36
Power Setting	10 in test utility software	Press. (mBars)	1001
Antenna	ANT=Taoglas	Duty Cycle (%)	100
Test Notes 1			
Test Notes 2			





# Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2456.084	68.0	7.2	30.6	105.7	Peak [Scan]	V						PK

Legend:

TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission



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# 7.7.11 DSSS Radiated Peak Emissions

Toc													
162	t Freq.	2441.75	5 MHz						Engineer	CSB			
\	/ariant	DSSS						T	emp (°C)	28			
Freq.	Range	2400 - 2	2483.5 N	ИHz				Rel.	Hum.(%)	36			
Power S	Setting	14 in te	st utility	software				Press.	(mBars)	1001			
Aı	ntenna	ANT=Ta	aoglas					Duty	Cycle (%)	100			
Test N	lotes 1												
Test N	lotes 2												
MiCOMLabs  dBu\/m Vasona by EMiSoft  01 Jul 10 14:13  [1] Horis Pk Lmt + Debug  1000  son  son  son  Sepandiated datassions Radiated datassions Frequency: M Freq													
	Formally measured emission peaks												
Formally Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments	
Frequency	Raw	Cable				Pol V	_			_		<b>Comments</b> PK	



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# 7.7.12 OOK Radiated Peak Emissions

Freq. F	ariant	2446.51 OOK	19						Engineer	CSB		
Freq. F		OOK							Engineer	COD		
Power S	Range							T	emp (°C)	28		
		2400 - 2	2483.5 N	ИHz				Rel.	Hum.(%)	36		
An	etting	Maximu	ım					Press.	(mBars)	1001		
	tenna	ANT=T	aoglas					Duty	Cycle (%)	100		
Test No	otes 1											
Test No	otes 2											
Formally r	meas	1101 1051 1001 950 900 900 800 24001	hame: C				44	15 D21V	oleth blotte Where Tag	+ Di		
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2447.178	67.0	7.2	30.5	104.7	Peak [Scan]	٧						PK
Legend:	TX = T	ransmitt	Insmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission									



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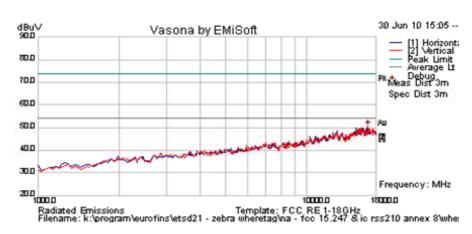
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# 7.7.13 Receiver Radiated Emissions

Test Freq.	2446.519 MHz	Engineer	CSB
Variant	оок	Temp (°C)	27.5
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum.(%)	32
Power Setting	Not Applicable in Receive Mode	Press. (mBars)	1003
Antenna	ANT=ZES10370		
Test Notes 1	EUT was tested at 100% duty cycle.		
Test Notes 2			





#### Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
No Receiver E	No Receiver Emissions within 6dB of limit.											
16841.683	40.2	8.6	1.8	50.5	Peak [Scan]	V	100	0	54.0	-3.5	Pass	Noise

Legend:

TRANS = Transient Emission; RB = Restricted Band; NRB = Non-Restricted Band;

BE = Emission in Restricted Band Nearest Transmission Band Edge; FUND = Fundamental Freq.



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# 7.8 Radiated Spurious Emissions – Below 1 GHz

#### **Test Procedure**

Testing was performed in a 3-meter anechoic chamber. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. Preliminary emissions were recorded with in Spectrum Analyzer mode, using a maximum peak detector while in peak hold mode.

Emissions nearest the limits were chosen for maximization and formal measurement using a CISPR Compliant receiver. Emissions from 30 MHz – 1000 MHz are measured utilizing a CISPR compliant quasi-peak detector with a tuned receiver, using a bandwidth of 120 kHz. Emissions above 1000 MHz are measured utilizing a CISPR compliant average detector with a tuned receiver, using a bandwidth of 1 MHz. Only the highest emissions relative to the limit are listed.

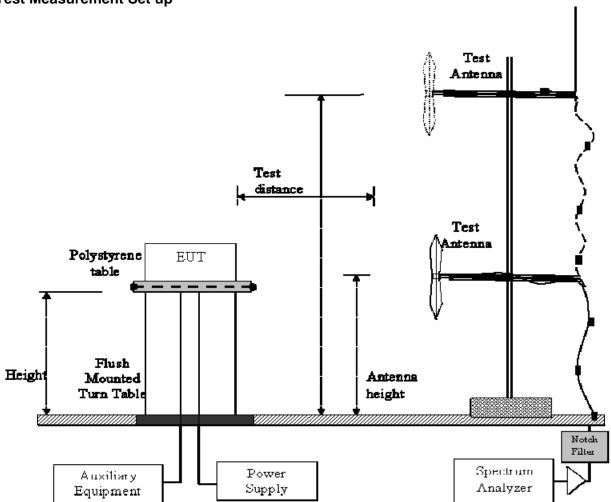


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#### **Test Measurement Set up**



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

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

#### Field Strength Calculation Example:

Given receiver input reading of 51.5 dB $_{\mu}$ 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:

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

Conversion between  $dB\mu V/m$  (or  $dB\mu V$ ) and  $\mu V/m$  (or  $\mu V$ ) are done as:

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

40 dB $\mu$ V/m = 100  $\mu$ V/m 48 dB $\mu$ V/m = 250  $\mu$ V/m



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#### **Specification**

#### **Radiated Spurious Emissions**

**FCC §15.247(d)** 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.

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)).

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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## **Table 1: FCC 15.209 Spurious Emissions Limits**

Frequency (MHz)	Field Strength (µV/m)	Field Strength (dBµV/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 Spectrum Measurement**

Measurement Uncertainty +5.6/ -4.5 dB
---------------------------------------

# Traceability:

Method	Test Equipment Used
Work instruction WI-03	0088, 0158, 0134, 0304, 0311, 0315, 0310, 0312



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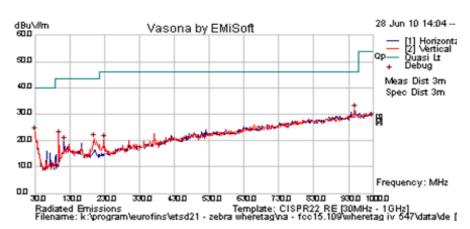
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# 7.8.1 <u>Measurement Results for Radiated Spurious Emissions Below 1 GHz - Antenna</u> ZES

Test Freq.	2441.75 MHz	Engineer	CSB					
Variant	Digital Emissions	Temp (°C)	29					
Freq. Range	30 MHz - 1000 MHz	Rel. Hum.(%)	37					
Power Setting	Max Pow er DSSS Mode	Press. (m Bars)	997					
Antenna	ANT=ZES10370	ANT=ZES10370						
Test Notes 1	EUT was operated in DSSS mode at maximum power for worst case operation							
Test Notes 2								





#### Formally measured emission peaks

Frequency M Hz	Raw dBuV	Cable Loss	A F dB	Level dBuV/m	M easurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	M argin dB	Pass /Fail	Comments
30.000	29.2	3.4	-9.2	23.4	Peak [Scan]	V	98	360	40	-16.6	Pass	DIG
98.377	39.1	4.1	-21.5	21.8	Peak [Scan]	V	98	360	43.5	-21.7	Pass	Amb
113.681	33.2	4.3	-17.9	19.6	Peak [Scan]	Н	98	360	43.5	-23.9	Pass	DIG
198.784	33.7	4.7	-18.0	20.5	Peak [Scan]	V	98	360	43.5	-23.0	Pass	DIG
228.223	34.5	4.9	-19.1	20.2	Peak [Scan]	V	98	360	46	-25.8	Pass	DIG
947.369	30.7	7.5	-6.7	31.5	Peak [Scan]	V	98	360	46	-14.5	Pass	DIG

Legend: DIG = Digital Device Emission; TX = Transmitter Emission; FUND = Fundamental Frequency

NRB = Non-Restricted Band, Limit is 20 dB below Fundamental; RB = Restricted Band



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# 7.8.2 <u>Measurement Results for Radiated Spurious Emissions Below 1 GHz - Antenna Taoglas</u>

Test Freq.	2441.75 MHz	Engineer	CSB			
Variant	Digital Emissions	Temp (°C)	29.5			
Freq. Range	30 MHz - 1000 MHz	Rel. Hum.(%)	37			
Power Setting	DSSS Mode - Maximum Pow er	Press. (m Bars)	997			
Antenna	WhereTag IV 547 ANT=Taoglas					
Test Notes 1	EUT was operated in DSSS mode at maximum power for worst case operation					
Test Notes 2						





#### Formally measured emission peaks

Frequency M Hz	Raw dBuV	Cable Loss	A F dB	Level dBuV/m	M easurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	M argin dB	Pass /Fail	Comments
30.000	29.9	3.4	-9.2	24.1	Peak [Scan]	Н	98	360	40	-15.9	Pass	DIG
97.985	40.0	4.1	-21.6	22.6	Peak [Scan]	V	98	360	43.5	-20.9	Pass	Amb
199.240	34.2	4.8	-17.9	21.1	Peak [Scan]	V	98	360	43.5	-22.4	Pass	DIG
372.013	32.5	5.6	-15.2	22.8	Peak [Scan]	V	98	360	46	-23.2	Pass	DIG
685.287	29.6	6.6	-10.0	26.2	Peak [Scan]	Н	98	360	46	-19.8	Pass	DIG
924.210	30.1	7.4	-7.2	30.3	Peak [Scan]	V	98	360	46	-15.7	Pass	DIG

Legend: DIG = Digital Device Emission; TX = Transmitter Emission; FUND = Fundamental Frequency

NRB = Non-Restricted Band, Limit is 20 dB below Fundamental; RB = Restricted Band



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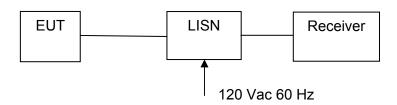
# 7.9 AC Mains Power Input/Output Port Emissions

No testing performed. EUT does not connect to AC Mains.

#### **Test Procedure**

The measurement frequency range extends from 150 kHz to 30 MHz. 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.

#### **Test Measurement Setup**



Measurement set up for Conducted Emissions Test

#### **Specification**

§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.



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#### Limits

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

<sup>\*</sup> Decreases with the logarithm of the frequency

# **Traceability**

All conducted emission measurements are traceable to national standards. The uncertainty of measurement at a confidence level of not less than 95 %, with a coverage factor of k=2, in the range 9 kHz - 30 MHz (Average & Quasi-peak) is  $\pm 2.64$  dB.

Laboratory Measurement Uncertainty	
Measurement uncertainty	±2.64 dB

Method	Test Equipment Used
Measurements were made per work	0158, 0184, 0193, 0190, 0293, 0307, 156,
instruction WI-EMC-01 'Measurement of	193, 190
Conducted Emissions'	



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# 8 PHOTOGRAPHS

# 8.1 Conducted RF Measurement Set Up





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# 8.2 Radiated Spurious Emissions Above 1 GHz - ZES Antenna



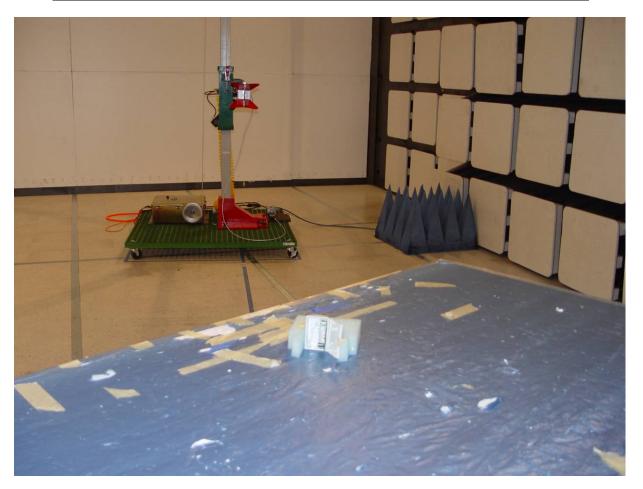


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# 8.3 Radiated Spurious Emissions Above 1 GHz - Taoglas Flexible Antenna





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# 8.4 Radiated Spurious Emissions Below 1 GHz





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# 9 TEST EQUIPMENT DETAILS

Asset #	Instrument	Manufacturer	Part #	Serial #
0075	Environmental Chamber	Thermatron	SE-300-2-2	27946
0088	Spectrum Analyzer	Hewlett Packard	8564E	3410A00141
0134	Amplifier	Com Power	PA 122	181910
0158	Barometer /Thermometer	Control Co.	4196	E2846
0287	EMI Receiver	Rhode & Schwartz	ESIB 40	100201
0252	SMA Cable	Megaphase	Sucoflex 104	None
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
0301	5.6 GHz Notch Filter	Micro-Tronics	RBC50704	001
0302	5.25 GHz Notch Filter	Micro-Tronics	BRC50703	002
0303	5.8 GHz Notch Filter	Micro-Tronics	BRC50705	003
0304	2.4GHzHz Notch Filter	Micro-Tronics		001
0307	BNC Cable	Megaphase	1689 1GVT4	15F50B002
0335	1-18GHz Horn Antenna	ETS- Lindgren	3117	00066580
0337	Amplifier	MiCOM Labs		
0338	Antenna	Sunol Sciences	JB-3	A052907



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