

Test of Zebra Enterprise Solutions Corp.
WhereLAN III Location Sensor

To: FCC 47 CFR Part 15.247 & IC 210

Test Report Serial No.: ZEBA03-U2 Draft



TEST REPORT

From



Test of: Zebra Enterprise Solutions Corp. WhereLAN III Location Sensor

To: FCC 47 CFR Part 15.247 & IC RSS-210

Test Report Serial No.: ZEBA03-U2 Draft

This report supersedes: None

Applicant: Zebra Technologies Corporation
333 Corporate Woods Parkway
Vernon Hills, IL 60061
USA

Product Function: Wireless Location Sensor

Copy No: pdf **Issue Date:** 17th April 2014

This Test Report is Issued Under the Authority of:

MiCOM Labs, Inc.

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MiCOM Labs is an ISO 17025 Accredited Testing Laboratory

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1 ACCREDITATION, LISTINGS & RECOGNITION

1.1 TESTING ACCREDITATION

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



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1.2 RECOGNITION

MiCOM Labs, Inc has widely recognized Electrical testing capabilities. Our international recognition includes Conformity Assessment Body designation by APEC MRA** countries. Our test reports are widely accepted for global type approvals.

Country	Recognition Body	Status	Phase	Identification No.
USA	Federal Communications Commission (FCC)	TCB	-	US0159 Listing #: 102167
Canada	Industry Canada (IC)	FCB	APEC MRA 2	US0159 Listing #: 4143A-2
Japan	MIC (Ministry of Internal Affairs and Communication)	CAB	APEC MRA 2	RCB 210
	VCCI	--	--	A-0012
Europe	European Commission	NB	EU MRA	NB 2280
Australia	Australian Communications and Media Authority (ACMA)	CAB	APEC MRA 1	US0159
Hong Kong	Office of the Telecommunication Authority (OFTA)	CAB	APEC MRA 1	
Korea	Ministry of Information and Communication Radio Research Laboratory (RRL)	CAB	APEC MRA 1	
Singapore	Infocomm Development Authority (IDA)	CAB	APEC MRA 1	
Taiwan	National Communications Commission (NCC) Bureau of Standards, Metrology and Inspection (BSMI)	CAB	APEC MRA 1	
Vietnam	Ministry of Communication (MIC)	CAB	APEC MRA 1	

**APEC MRA – Asia Pacific Economic Community Mutual Recognition Agreement.

Is a recognition agreement under which test lab is accredited to regulatory standards of the APEC member countries.

Phase I - recognition for product testing

Phase II – recognition for both product testing and certification

N/A – Not Applicable

**EU MRA – European Union Mutual Recognition Agreement.

Is a recognition agreement under which test lab is accredited to regulatory standards of the EU member countries.

**NB – Notified Body

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1.3 PRODUCT CERTIFICATION

MiCOM Labs, Inc. is an accredited Product Certification Body per the international standard EN ISO/IEC 17065. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.02. MiCOM Labs test schedule is available at the following URL; <http://www.a2la.org/scopepdf/2381-02.pdf>



United States of America – Telecommunication Certification Body (TCB)
TCB Identifier – US0159

Industry Canada – Certification Body
CAB Identifier – US0159

Europe – Notified Body
Notified Body Identifier - 2280

Japan – Recognized Certification Body (RCB)
RCB Identifier - 210

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2 DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft		
Rev A	17th April 2014	Initial Release

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3 TEST RESULT CERTIFICATE

Applicant:	Zebra Technologies Corporation 333 Corporate Woods Parkway Vernon Hills, IL 60061 USA	Tested By:	MiCOM Labs, Inc. 575 Boulder Court Pleasanton California, 94566, USA
Product:	WhereLAN III Location Sensor	Telephone:	+1 925 462 0304
Model No.:	LOS-5000	Fax:	+1 925 462 0306
S/No's:	M40491305Z14		
Date(s) Tested:	25 th March to 2 nd April 2014	Website:	www.micomlabs.com

STANDARD(S)

FCC 47 CFR Part 15.247 & IC 210

TEST RESULTS

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.

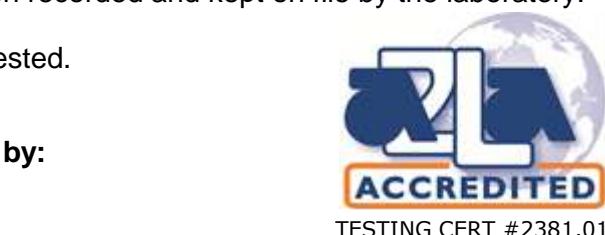
Notes:

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:


Graeme Grieve

Quality Manager MiCOM Labs, Inc.




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.	FCC 47 CFR Part 15, Subpart C	2010	Title 47: Telecommunication PART 15—RADIO FREQUENCY DEVICES Subpart C—Intentional Radiators
ii.	RSS-210 Annex 8	2010	Radio Standards Specification 210, Issue 8, Low-power License-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment
iii.	FCC OET KDB 662911	4 th April 2011	Emissions Testing of Transmitters with Multiple Outputs in the Same Band
iv.	DA 00-705	2000	FCC DA 00-705 “Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems” released March 30, 2000
v.	RSS-GEN	2010	Radio Standards Specification-Gen, Issue 3, General Requirements and Information for the Certification of Radiocommunication Equipment
vi.	FCC 47 CFR Part 15	2010	47 CFR Part 15, SubPart B; Unintentional Radiators
vii.	ICES-003	2004	Spectrum Management and Telecommunications Policy Interference-Causing Equipment Standard Digital Apparatus; Issue 4
viii.	ANSI C63.4	2009	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
ix.	CISPR 22/ EN 55022	2008 2006+A1:2007	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
x.	M 3003	Edition 1 Dec. 1997	Expression of Uncertainty and Confidence in Measurements
xi.	LAB34	Aug 2002	The expression of uncertainty in EMC Testing
xii.	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
xiii.	A2LA	July 2012	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 the **FCC CFR47 Part 15.247** and **Industry Canada RSS-210** and **Industry Canada RSS-Gen**.

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.247(a)(2) A8.2(1) 4.4	6 dB and 99 % Bandwidths	≥500 kHz	Conducted	Complies	8.1
15.247(b)(3) 15.31(e) A8.4(4)	Peak Output Power Voltage Variation	Shall not exceed 1W Variation of supply voltage 85 % -115 %	Conducted	Complies	8.2
15.247(e) A8.2	Peak Power Spectral Density	Shall not be greater than +8 dBm in any 3 kHz band	Conducted	Complies	8.3
15.247(d) 15.205 / 15.209 A8.5 2.2 4.7	Spurious Emissions (30MHz - 26 GHz b/g and 30 MHz – 40 GHz a)	The radiated emission in any 100 kHz of out-band shall be at least 20 dB below the highest in-band spectral density	Conducted	Complies	8.4

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List of Measurements (continued)

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

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.247(d) 15.205 / 15.209 A8.5 2.2 2.6 4.7	Radiated Emissions	Restricted Bands	Radiated	Complies	8.5
	Transmitter Radiated Spurious Emissions	Emissions above 1 GHz		Complies	
	Radiated Band Edge	Band-edge results Peak Emissions		Complies	
15.205 / 15.209 2.2	Radiated Spurious Emissions	Emissions <1 GHz (30M-1 GHz)	Radiated	Complies	8.6
15.207 7.2.2	AC Wireline Conducted Emissions 150 kHz–30 MHz	Conducted Emissions	Conducted	Complies	8.7

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 2.7 Equipment Modifications highlights the equipment modifications that were required to bring the product into compliance with the above test matrix

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6 PRODUCT DETAILS AND TEST CONFIGURATIONS

6.1 Test Program Scope

The scope of the test program was to test the Zebra Technologies Corp. WhereLAN III Location Sensor Wireless Location System for compliance against FCC 47 CFR Part 15, SubPart 15.247 & IC RSS-210.

APPLICANT: Zebra Technologies Corporation

PRODUCT: WhereLAN III LOCATION SENSOR



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APPLICANT: Zebra Technologies Corporation

PRODUCT: WhereLAN III LOCATION SENSOR



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APPLICANT: Zebra Technologies Corporation

PRODUCT: WhereLAN III LOCATION SENSOR



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6.2 EUT Details

Detail	Description
Purpose:	Test of the Zebra Technologies Corporation WhereLAN III Location Sensor Wireless Location System for compliance against FCC 47 CFR Part 15, SubPart 15.247 & IC RSS- 210
Applicant:	Zebra Technologies Corporation
Manufacturer:	Zebra Technologies Corporation
Test Laboratory:	MiCOM Labs, Inc. 575 Boulder Court Pleasanton, California 94566 USA
Test report reference number:	ZEBA03-U2
Date EUT received:	18 th March 2014
Dates of test (from - to):	25 th March to 2 nd April 2014
No of Units Tested:	1
Product Name:	WhereLAN III Location Sensor
Manufacturers Trade Name:	WhereLAN III Location Sensor
Model No.:	LOS-5000
Equipment Primary Function:	Wireless Location System
Equipment Secondary Function(s):	None
Type of Technology:	DSSS
Installation type:	Fixed
Construction/Location for Use:	Indoor/Outdoor
Software/Firmware Release:	Unknown
Hardware Release:	Rev B
Test Software Release:	Windows XP HyperTerminal
Transmit/Receive Operation:	Full Duplex
Output Power Type	Stepped fixed for ISO
Automatic Transmit Power Control Available:	N/A
Remote Frequency Control Available:	N/A
Operating Frequency:	2441.75 MHz
Rated Input Voltage and Current DC:	Nominal: 48.0 Vdc Max: 36.0 Vdc Min: 57.0 Vdc Current: 0.35 (A)
Operating Temperature Range °C:	Min: -40 Max: +60°C
ITU Emission Designator(s):	ISO24730 DSSS BPSK
Long Term Frequency Stability:	20 ppm
Equipment Dimensions:	10.25 in X 12.25 in X 1.50 in
Weight:	7 lbs

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6.3 External A.C/D.C Power Adaptor

Type	Manufacturer	Manufacturers P/N	Input	Output
POE	ITE	PW182RB4800F 01	100-240V (50-60Hz) 0.6A	48Vdc 0.35A

6.4 Operational Power Range

Declared O/P Power Range	Mode 1	
	Max	Min
EUT	24.0	0

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6.5 Types of Modulation Supported

Modulation / Mode	Bandwidth
DSSS	60 MHz

6.6 Antenna Details

The following is a description of the EUT antennas.

Antenna Type:	Manufacturer	Model	Gain (dBi)	Frequency Range (MHz)
Helical	Zebra Technology Corp	AK-110-10	3	2412-2462
Helical	Zebra Technology Corp	AK-120-10	3	2412-2462

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)	Qty
RJ-45	Ethernet	N	1
RJ-22	Timing Ports	N	3
DB-9 Male	Serial Port (configuration only)	N	1
MCX female	RF output ports	Y	2
SMB male	RF output port for WIFI	Y	1

6.8 EUT Configurations

Band (GHz)	Mode	Freq Band (MHz)	Freq Range (MHz)	Low ch	Mid ch	High ch	# Ch	Ch Spacing (MHz)	ChBW (MHz)
2.4	DSSS	2400 - 2483.5	2412 - 2462	--	2441.75	--	1	--	67

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	Location Sensor	Zebra Enterprise Solutions Corp.	LOS-5000	LOS-5000-01AA
Support	Laptop PC	IBM		

6.10 Test Configurations

Operational Mode(s)	Data Rate Tested
DSSS	59.7 kbps

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6.11 Equipment Modifications

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

- No modifications required.

6.12 Deviations from the Test Standard

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

- No deviations necessary

7 TEST EQUIPMENT CONFIGURATION(S)

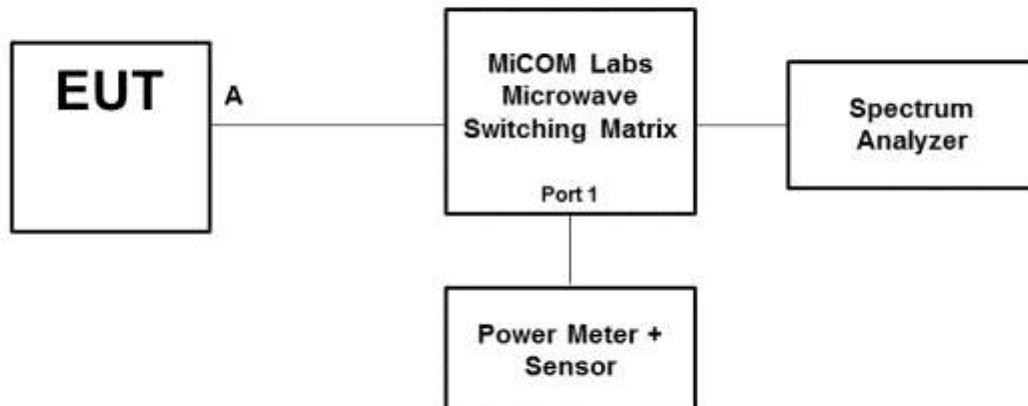
7.1 Conducted RF Emission Test Set-up

The following tests were performed using the conducted test set-up shown in the diagram below.

1. Section 8.1 6 dB and 99% Bandwidth
2. Section 8.2. Peak Output Power
3. Section 8.3. Power Spectral Density
4. Section 8.4. Conducted Spurious Emissions

Conducted Test Set-Up Pictorial Representation

Test Measurement set up



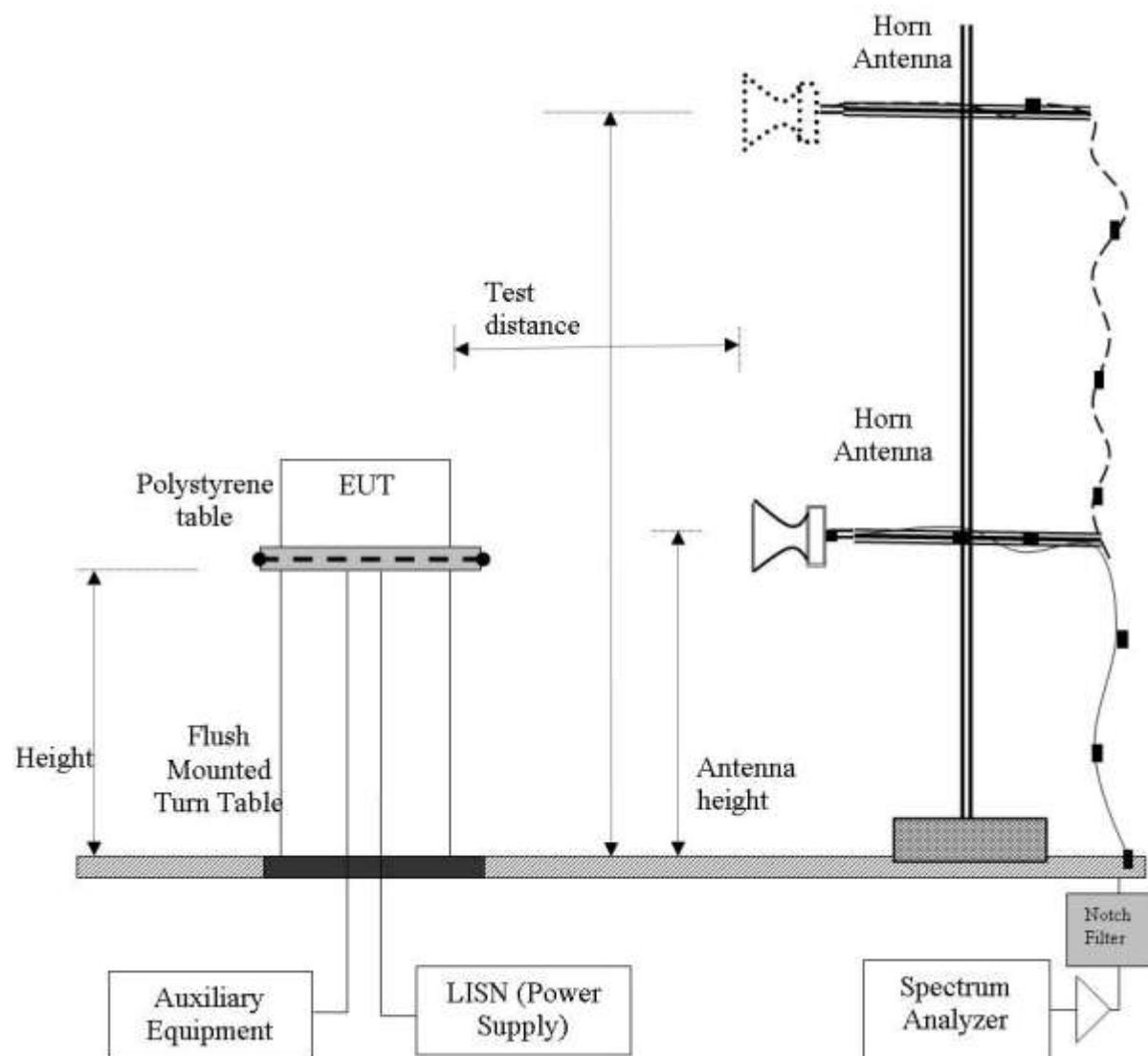
Conducted Test Measurement Setup

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7.2 Radiated Spurious Emission Test Set-up > 1 GHz

The following tests were performed using the conducted test set-up shown in the diagram below.

Radiated Emission Measurement Setup – Above 1 GHz

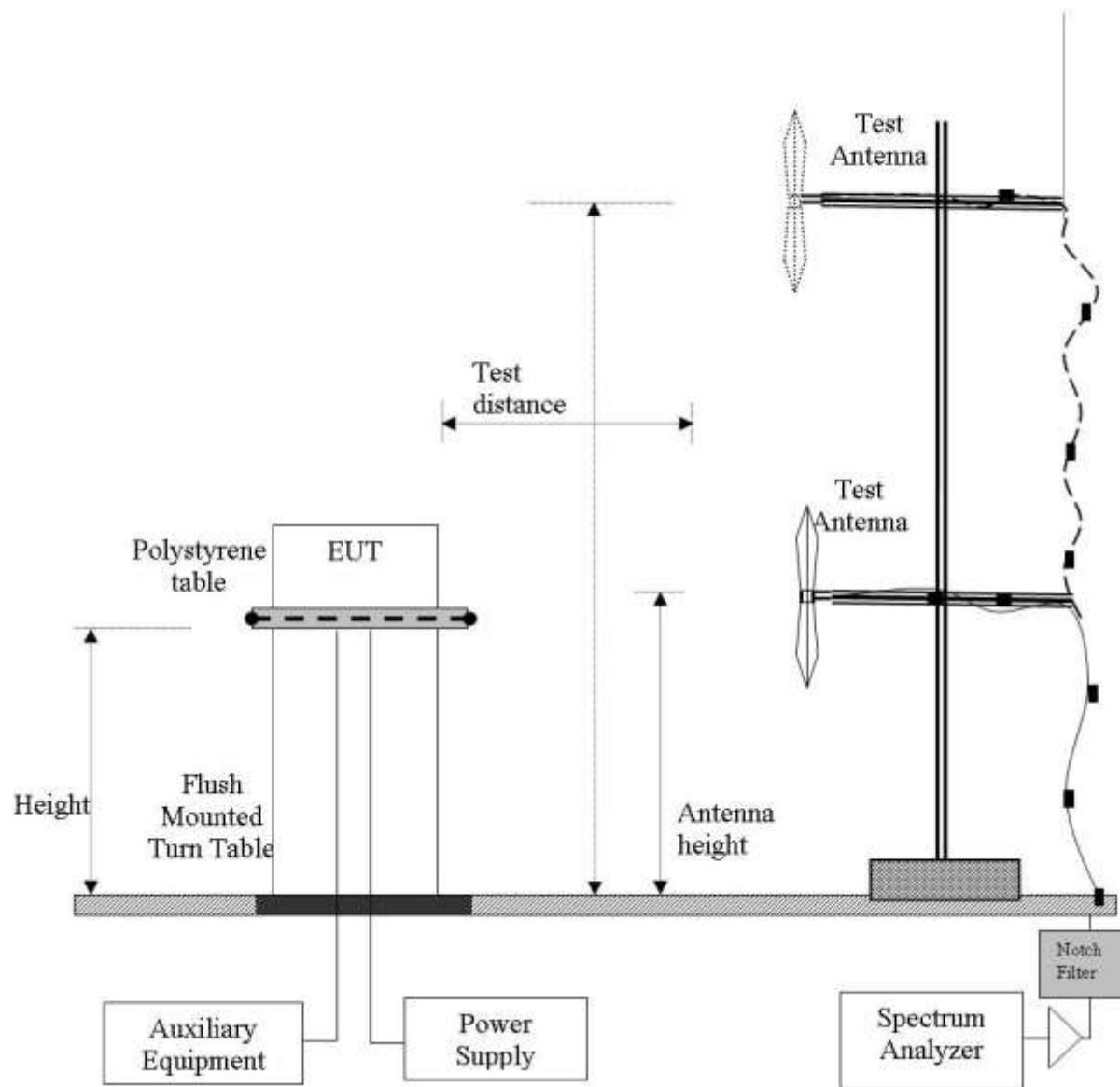


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7.3 Digital Emissions Test Set-up (0.03 – 1 GHz)

The following tests were performed using the conducted test set-up shown in the diagram below.

Digital Emission Measurement Setup – Below 1 GHz



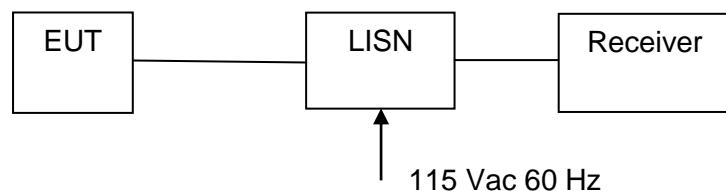
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7.4 ac Wireline Emission Test Set-up

The following tests were performed using the conducted test set-up shown in the diagram below.

1. Section 5.1.3 ac Wireline Conducted Emissions

Conducted Test Set-Up Pictorial Representation



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8 TEST RESULTS

8.1 6 dB and 99% Bandwidth

Conducted Test Conditions for 6 dB and 99% Bandwidth			
Standard:	FCC CFR 47:15.247	Ambient Temp. (°C):	24.0 - 27.5
Test Heading:	6 dB and 99 % Bandwidth	Rel. Humidity (%):	32 - 45
Standard Section(s):	15.247 (a)(2)	Pressure (mBars):	999 - 1001
Reference Document(s):	KDB 558074 - D01 DTS Measurement Guidance v01: Section 5.1 Emission Bandwidth		
Test Procedure for 6 dB and 99% Bandwidth Measurement The bandwidth at 6 dB and 99 % was measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate center frequency.			

Specification

Limits

§15.247 (a)(2) & RSS-210 §A8.2(1)

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

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

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

Traceability

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

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Equipment Configuration for 6 dB & 99% Bandwidth

Variant:	DSSS	Duty Cycle (%):	99
Data Rate:	N/A	Antenna Gain (dBi):	Not Applicable
Modulation:	DSSS	Beam Forming Gain (Y):	Not Applicable
TPC:	Not Applicable	Tested By:	SB
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured 6 dB Bandwidth (MHz)				6 dB Bandwidth (MHz)		Limit	Lowest Margin
	Port(s)				Highest	Lowest		
MHz	a	b	c	d			KHz	MHz
2441.8	28.377	--	--	--	28.377	28.377	≥500.0	-27.88

Test Frequency	Measured 99% Bandwidth (MHz)				Maximum 99% Bandwidth (MHz)		
	Port(s)						
MHz	a	b	c	d			
2441.8	44.729	--	--	--	44.729		

Traceability to Industry Recognized Test Methodologies

Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Note: click the links in the above matrix to view the graphical image (plot).

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8.2 Peak Output Power

Conducted Test Conditions for Fundamental Emission Output Power			
Standard:	FCC CFR 47:15.247	Ambient Temp. (°C):	24.0 - 27.5
Test Heading:	Emission Output Power	Rel. Humidity (%):	32 - 45
Standard Section(s):	15.247 (a)(2)	Pressure (mBars):	999 - 1001
Reference Document(s):	KDB 558074 - D01 DTS Measurement Guidance v01: Section 5.2 Fundamental Emission Output Power KDB 662911 was implemented for In-band power measurements. The measure and sum technique was implemented in all cases.		

Test Procedure for Fundamental Emission Output Power Measurement

Selection of the detector type is determined by the client, either a peak detector or average power detector can be selected however the same detector type **must** be used for each of the following tests;

- A). Output Power
- B).. Power Density
- C).. Conducted Spurious Emissions

Average Power

To measure average power a power meter measuring average power is implemented

Peak Detector

To measure peak power a spectrum analyser is used with the peak detector selected. The transmitter terminal of EUT was connected to the input of the spectrum analyser. The resolution filter bandwidth was set for 6 dB and the analyzers built-in power function used to integrate peak power over the EUT's 20 dB bandwidth.

Supporting Information

Calculated Power = $A + G + 10 \log (1/x)$ dBm
A = Total Power [$10 \log_{10} (10^{a/10} + 10^{b/10} + 10^{c/10} + 10^{d/10})$], G = Antenna Gain,
x = Duty Cycle

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To: FCC 47 CFR Part 15.247 & IC RSS-210
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Equipment Configuration for Peak Output Power

Variant:	DSSS	Duty Cycle (%):	99
Data Rate:	N/A	Antenna Gain (dBi):	3.00
Modulation:	DSSS	Beam Forming Gain (Y):	Not Applicable
TPC:	Not Applicable	Tested By:	SB
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Output Power (dBm)				Calculated Total Power Σ Port(s)	Limit	Margin	EUT Power Setting
	Port(s)							
MHz	a	b	c	d	dBm	dBm	dBm	
2441.8	17.09				17.09	30.00	-12.91	Mid Power

Traceability to Industry Recognized Test Methodologies

Work Instruction:	WI-01 MEASURING RF OUTPUT POWER
Measurement Uncertainty:	±1.33 dB

Note: click the links in the above matrix to view the graphical image (plot).

Note: compliant power level is the Mid Power Setting

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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.

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

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	0158, 0287, 0252, 0313, 0314, 0070, 0116, 0117

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8.3 Peak Power Spectral Density

Conducted Test Conditions for Power Spectral Density			
Standard:	FCC CFR 47:15.247	Ambient Temp. (°C):	24.0 - 27.5
Test Heading:	Power Spectral Density	Rel. Humidity (%):	32 - 45
Standard Section(s):	15.247 (e)	Pressure (mBars):	999 - 1001
Reference Document(s):	KDB 558074 - D01 DTS Measurement Guidance v01: Section 5.3 Maximum Power Spectral Density Level in the Emission Bandwidth		

Test Procedure for Power Spectral Density

The transmitter output was connected to a spectrum analyzer and the maximum spectral emission was measured in a 30 kHz bandwidth for each antenna chain. Sweep time was auto selected by the analyzer which was set for max hold. Once the maximum emission was found the emission(s) were summed for each chain.

As the FCC limit is provided for a 3 kHz resolution bandwidth the measured data required to be converted.

Spectral Density Conversion Factor

$10 * \log (3 \text{ kHz} / \text{measurement bandwidth}) = 10 * \log (3/30) = -10 \text{ dB}$

Detector Selection

Selection of the analyzer detector is determined by the client, however the same detector type **must** be used for each of the following tests;

- A). Output Power
- B).. Power Density
- C).. Conducted Spurious Emissions

Supporting Information

Calculated Power = $A + 10 \log (1/x) \text{ dBm}$

$A = \text{Total Power Spectral Density} [10 \log_{10} (10^{a/10} + 10^{b/10} + 10^{c/10} + 10^{d/10})]$

$x = \text{Duty Cycle}$

Limit Line: KDB 662911 was implemented for In-band power spectral density (PSD) measurements - Option (2) measure and subtract 10 log (N) dB from the limit for devices with multiple RF ports.

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Specification

Peak Power Spectral Density Limits

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

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

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-01 'Measuring RF Output Power'	0158, 0287, 0252, 0313, 0314, 0070, 0116, 0117

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Equipment Configuration for Power Spectral Density - Peak

Variant:	DSSS	Duty Cycle (%):	99
Data Rate:	N/A	Antenna Gain (dBi):	Not Applicable
Modulation:	DSSS	Beam Forming Gain (Y):	Not Applicable
TPC:	Not Applicable	Tested By:	SB
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured Power Spectral Density (dBm)				Calculated Total Power Spectral Density		Limit	Margin
	Port(s)				dBm			
MHz	a	b	c	d	Σ Port(s) per 30kHz RBW	Conversion to 3 kHz RBW	dBm	dB
2441.8	1.144	--	--	--	1.144	-8.856	8.00	-16.86

Traceability to Industry Recognized Test Methodologies

Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Note: click the links in the above matrix to view the graphical image (plot).

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8.4 Conducted Spurious

Conducted Test Conditions for Transmitter Conducted Spurious and Band-Edge Emissions						
Standard:	FCC CFR 47:15.247	Ambient Temp. (°C):	24.0 - 27.5			
Test Heading:	Max Unwanted Emission Levels	Rel. Humidity (%):	32 - 45			
Standard Section(s):	15.247 (d)	Pressure (mBars):	999 - 1001			
Reference Document(s):	KDB 558074 - D01 DTS Measurement Guidance v01: Section 5.4 Maximum Unwanted Emission Levels					
Test Procedure for Transmitter Conducted Spurious and Band-Edge Emissions Measurement Transmitter Conducted Spurious and Band-Edge emissions were measured with a spectrum analyzer connected to the antenna terminal using one of the following limits;						
1).. Peak Detector - 20 dB below the highest in-band spectral density (i.e. 20 dBc)						
2).. Average Detector – 30 dB below the highest in-band spectral density (i.e. 30 dBc)						
Selection of the analyzer detector is determined by the client, however the same detector type must be used for each of the following tests;						
A). Output Power						
B).. Power Density						
C).. Conducted Spurious Emissions						
Measurements were made while EUT was operating in transmit mode of operation at the appropriate centre frequency closest to the band-edge. Emissions were maximized during the measurement and limits derived from the peak spectral power and drawn on each plot.						

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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	

§15.247(d) and RSS-210 §A8.5 In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

§15.247(d)

If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section §15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(a)).

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

RSS-Gen §4.7

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

Laboratory Measurement Uncertainty for Conducted Spurious Emissions

Measurement uncertainty	±2.37 dB
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Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-05 'Measurement of Spurious Emissions'	0088, 0158, 0287, 0252, 0313, 0314, 0070, 0116, 0117.

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Equipment Configuration for Conducted Low Band-Edge Emissions - Peak

Variant:	DSSS	Duty Cycle (%):	99
Data Rate:	N/A	Antenna Gain (dBi):	Not Applicable
Modulation:	DSSS	Beam Forming Gain (Y):	Not Applicable
TPC:	Not Applicable	Tested By:	SB
Engineering Test Notes:			

Test Measurement Results

Channel Frequency:	2441.8 MHz				
Band-Edge Frequency:	2400.0 MHz				
Test Frequency Range:	2292.0 - 2442.0 MHz				
Port(s)	Band-Edge Markers and Limit			Amended Limit	Margin
	M1 Amplitude (dBm)	Plot Limit (dBm)	M2 Frequency (MHz)	Amplitude (dBm)	M2A Frequency (MHz)
a	-25.49	-16.41	2415.50	--	--
					-15.500

Traceability to Industry Recognized Test Methodologies

Work Instruction:	WI-05 MEASUREMENT OF SPURIOUS EMISSIONS	
Measurement Uncertainty:	$\leq 40 \text{ GHz} \pm 2.37 \text{ dB}$, $> 40 \text{ GHz} \pm 4.6 \text{ dB}$	

Note: click the links in the above matrix to view the graphical image (plot).

Equipment Configuration for Conducted High Band-Edge Emissions - Peak

Variant:	DSSS	Duty Cycle (%):	99
Data Rate:	N/A	Antenna Gain (dBi):	Not Applicable
Modulation:	DSSS	Beam Forming Gain (Y):	Not Applicable
TPC:	Not Applicable	Tested By:	SB
Engineering Test Notes:			

Test Measurement Results

Channel Frequency:	2441.8 MHz				
Band-Edge Frequency:	2483.5 MHz				
Test Frequency Range:	2432.0 - 2582.0 MHz				
Port(s)	Band-Edge Markers and Limit			Amended Limit	Margin
	M3 Amplitude (dBm)	Plot Limit (dBm)	M2 Frequency (MHz)	Amplitude (dBm)	M2A Frequency (MHz)
a	-23.74	-16.41	2465.10	--	--
					-18.400

Traceability to Industry Recognized Test Methodologies

Work Instruction:	WI-05 MEASUREMENT OF SPURIOUS EMISSIONS	
Measurement Uncertainty:	$\leq 40 \text{ GHz} \pm 2.37 \text{ dB}$, $> 40 \text{ GHz} \pm 4.6 \text{ dB}$	

Note: click the links in the above matrix to view the graphical image (plot).

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Equipment Configuration for Transmitter Conducted Spurious Emissions

Variant:	DSSS	Duty Cycle (%):	99
Data Rate:	N/A	Antenna Gain (dBi):	Not Applicable
Modulation:	DSSS	Beam Forming Gain (Y):	Not Applicable
TPC:	Not Applicable	Tested By:	SB
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Frequency Range	Transmitter Conducted Spurious Emissions (dBm)							
		Port a		Port b		Port c		Port d	
MHz	MHz	SE	Limit	SE	Limit	SE	Limit	SE	Limit
2441.8	30.0 - 26000.0	<u>-49.373</u>	-17.72	--	--	--	--	--	--

Traceability to Industry Recognized Test Methodologies

Work Instruction:	WI-05 MEASUREMENT OF SPURIOUS EMISSIONS
Measurement Uncertainty:	$\leq 40 \text{ GHz} \pm 2.37 \text{ dB}$, $\geq 40 \text{ GHz} \pm 4.6 \text{ dB}$

Note: click the links in the above matrix to view the graphical image (plot).

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8.5 Radiated Spurious Emissions

Transmitter Radiated Spurious Emissions (above 1 GHz); Peak Field Strength Measurements; and Radiated Band Edge Measurements – Restricted Bands

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

Industry Canada RSS-210 §A8.5, §2.2, §2.6, Industry Canada RSS-Gen §4.7

Test Procedure

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

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

Field Strength Calculation

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

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

where: FS = Field Strength

R = Measured Spectrum analyzer Input Amplitude

AF = Antenna Factor

CORR = Correction Factor = CL – AG + NFL

CL = Cable Loss

AG = Amplifier Gain

FO = Distance Falloff Factor

NFL = Notch Filter Loss or Waveguide Loss

For example:

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

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

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

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

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

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

NOTE: KDB 662911 was implemented for Out-of-Band measurements. Where necessary Option (2) Measure and add 10 log (N) dB was implemented

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Specification Limits

FCC §15.247(d) and RSS-210 §A8.5 In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

FCC §15.247(d)

If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section §15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(a)).

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

IC RSS-Gen §4.7

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

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

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

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



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Table 1: FCC 15.209 and RSS-Gen §6 Spurious Emissions Limits

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

Laboratory Measurement Uncertainty for Radiated Emissions

Measurement Uncertainty	+5.6/ -4.5 dB

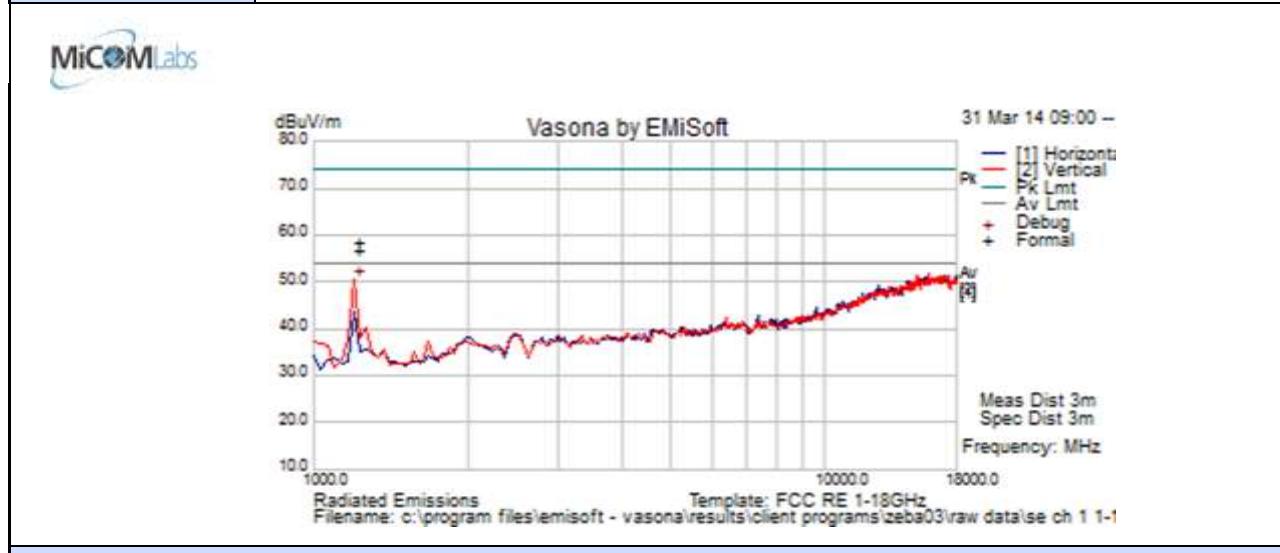
Traceability:

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

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8.5.1 Measurement Results DSSS mode: Transmitter Radiated Spurious Emissions

Test Freq.	2441.75 MHz	Engineer	SB
Variant	802.11b; 1 Mbit/s	Temp (°C)	23
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum. (%)	33
Power Setting	High Power	Press. (mBars)	1008
Antenna	AK-110	Duty Cycle (%)	100
Test Notes 1	AC/DC adapter on floor;		
Test Notes 2	Duty Cycle Correction Factor Applied		



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		
1220.998	63.9	2.8	-8.3	58.3	Peak Max	V	105	154	74.0	-15.7	Pass	RB		
1220.998	62.3	2.8	-8.3	56.8	Average Max	V	105	154	54.0	-29.07	Pass*	Need DCF		
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												

* Duty cycle corrected : The emission was found to be related to the transmitter and the following duty cycle was applied.

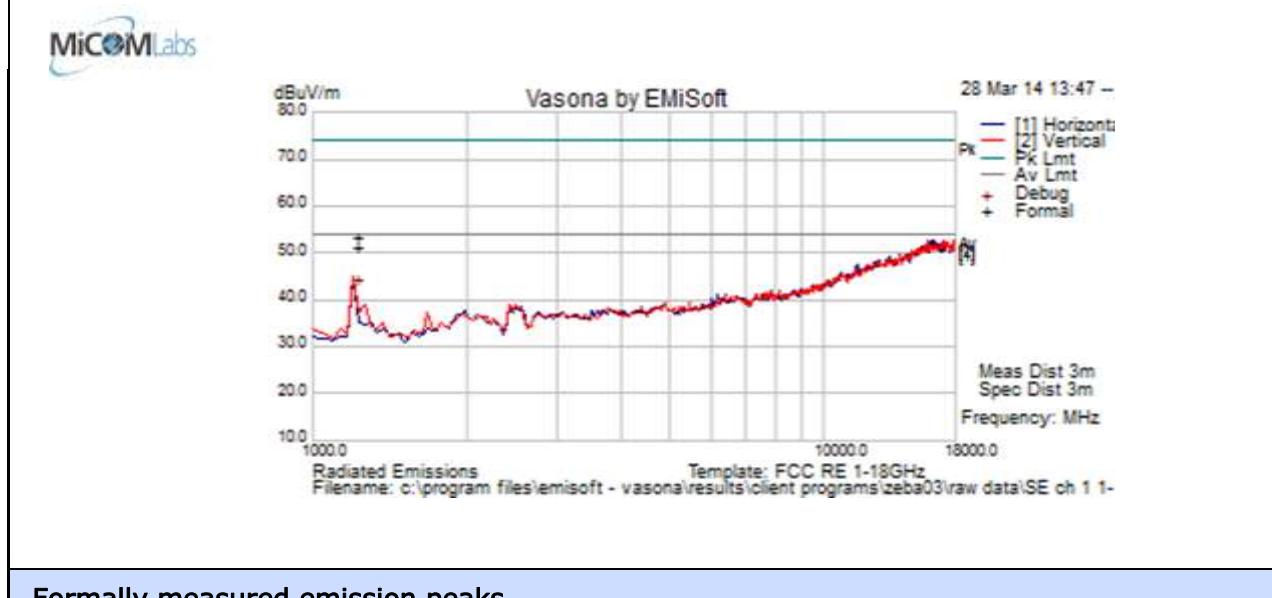
Client declared maximum EUT operational duty cycle: 2.55%

Correction Factor = $20 * \log (2.55 / 100)$

Correction Factor = -31.87 dB

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

Test Freq.	2441.75 MHz	Engineer	SB
Variant	802.11b; 1 Mbs	Temp (°C)	23
Freq. Range	1000 MHz - 18000 MHz	Rel. Hum. (%)	33
Power Setting	High Power	Press. (mBars)	1008
Antenna	AK-210-10	Duty Cycle (%)	100
Test Notes 1	AC/DC adapter on floor;		
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
1220.893	58.8	2.8	-8.3	53.2	Peak Max	H	103	145	74.0	-20.8	Pass	
1220.893	56.7	2.8	-8.3	51.1	Average Max	H	103	145	54.0	-2.9	Pass	
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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8.5.2 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

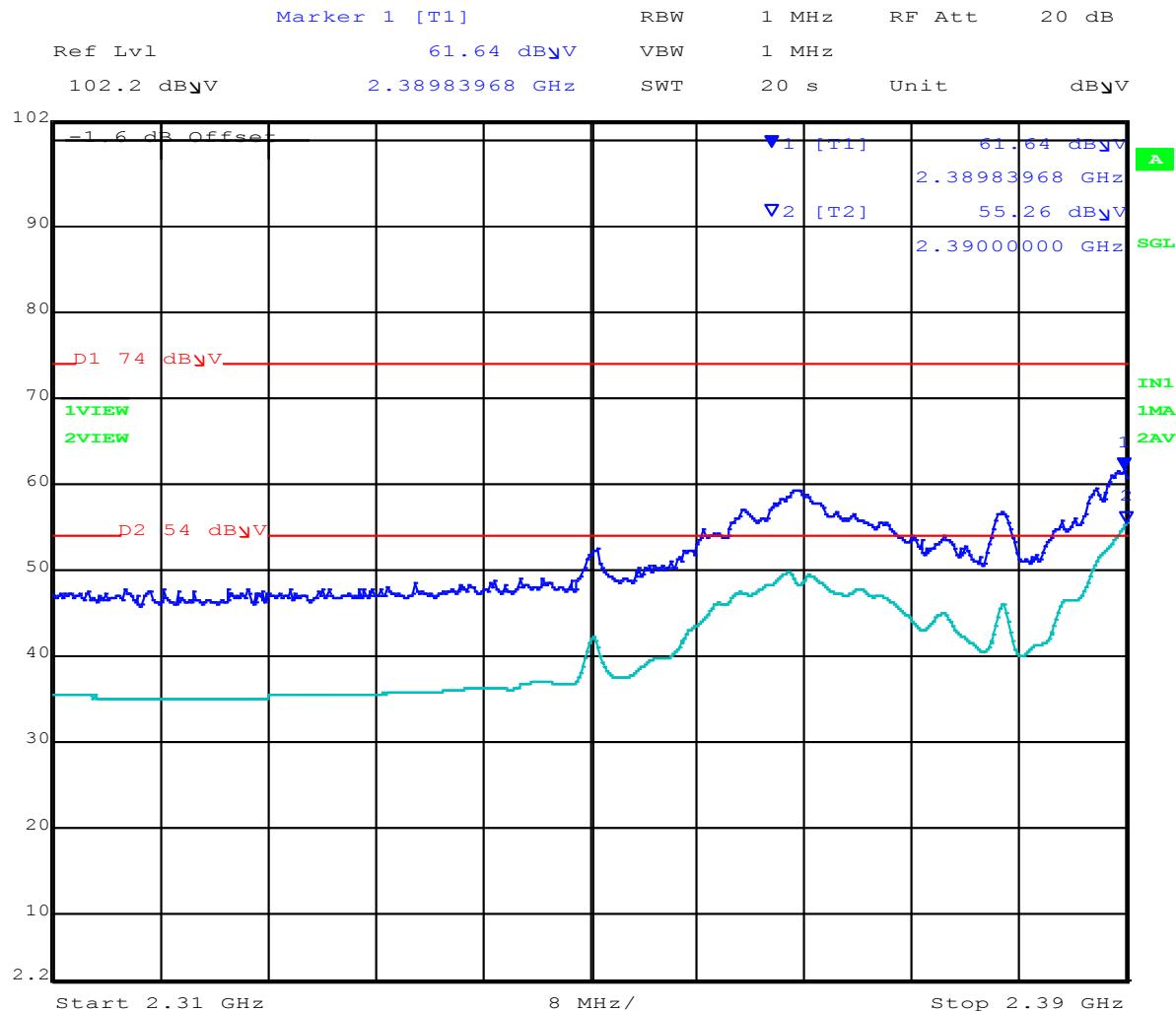
Corrected Value = Measured Value (dB) - 31.87 (dB)

Power setting for band-edge = Mid

Frequency Range (MHz)	Measurement Type	Measured Value (dBuV/m)	Corrected Value (dBuV/m)	Margin (dB)	Pass / Fail
Antenna AK-110					
2310.0 – 2390.0	Peak	61.64	--	-12.36	Pass
2310.0 – 2390.0	Average	55.26	23.39	-30.61	Pass
2483.5 – 2500.0	Peak	71.52	--	-2.48	Pass
2483.5 – 2500.0	Average	63.34	31.47	-31.87	Pass
Antenna AK-210-10					
2310.0 – 2390.0	Peak	62.47	--	-38.18	Pass
2483.5 – 2500.0	Average	56.74	24.87	-29.13	Pass
2310.0 – 2390.0	Peak	71.38	--	-2.62	Pass
2483.5 – 2500.0	Average	63.80	31.93	-22.07	Pass

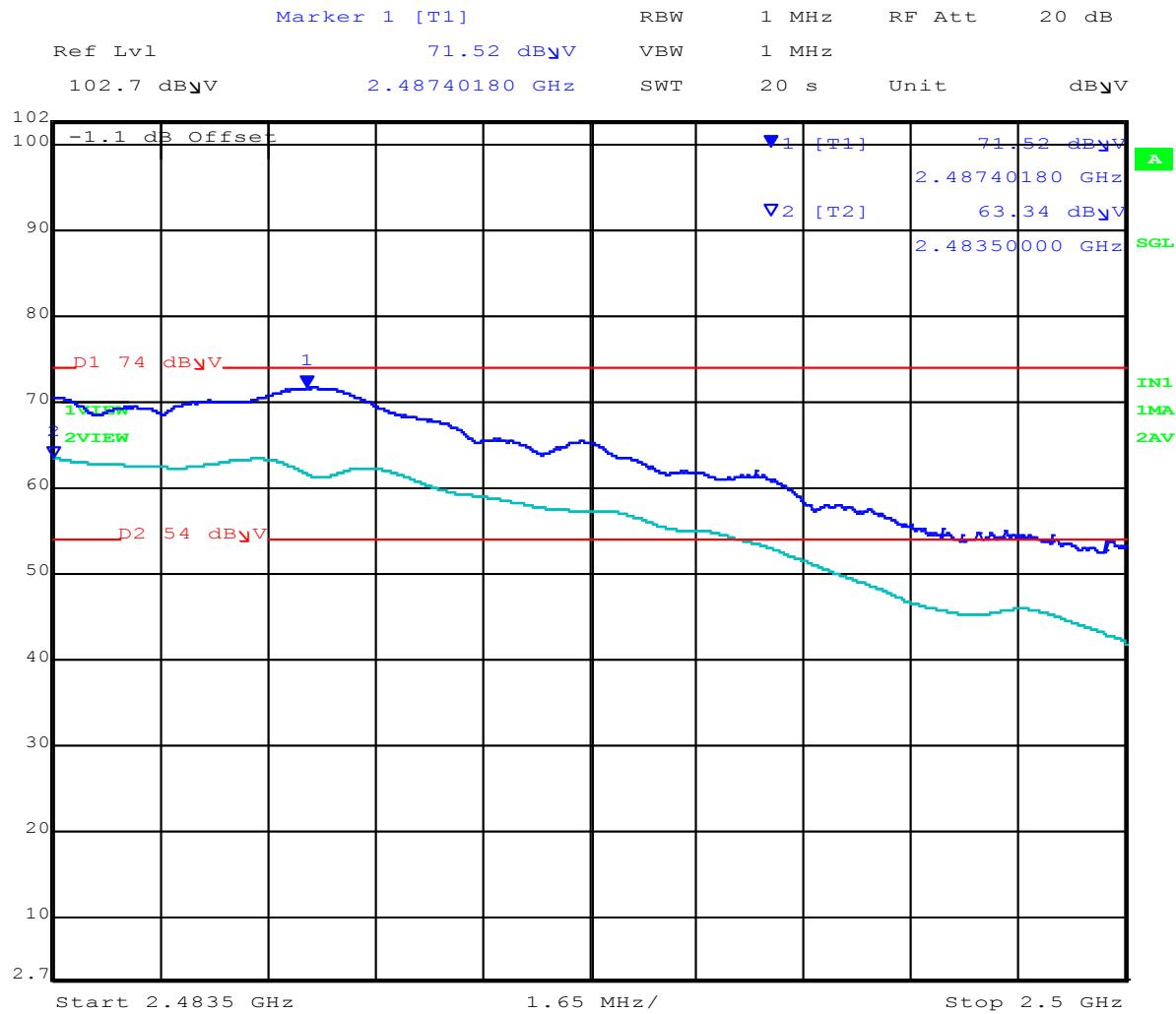
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Antenna AK-110 : 2390 MHz Restricted Band-Edge



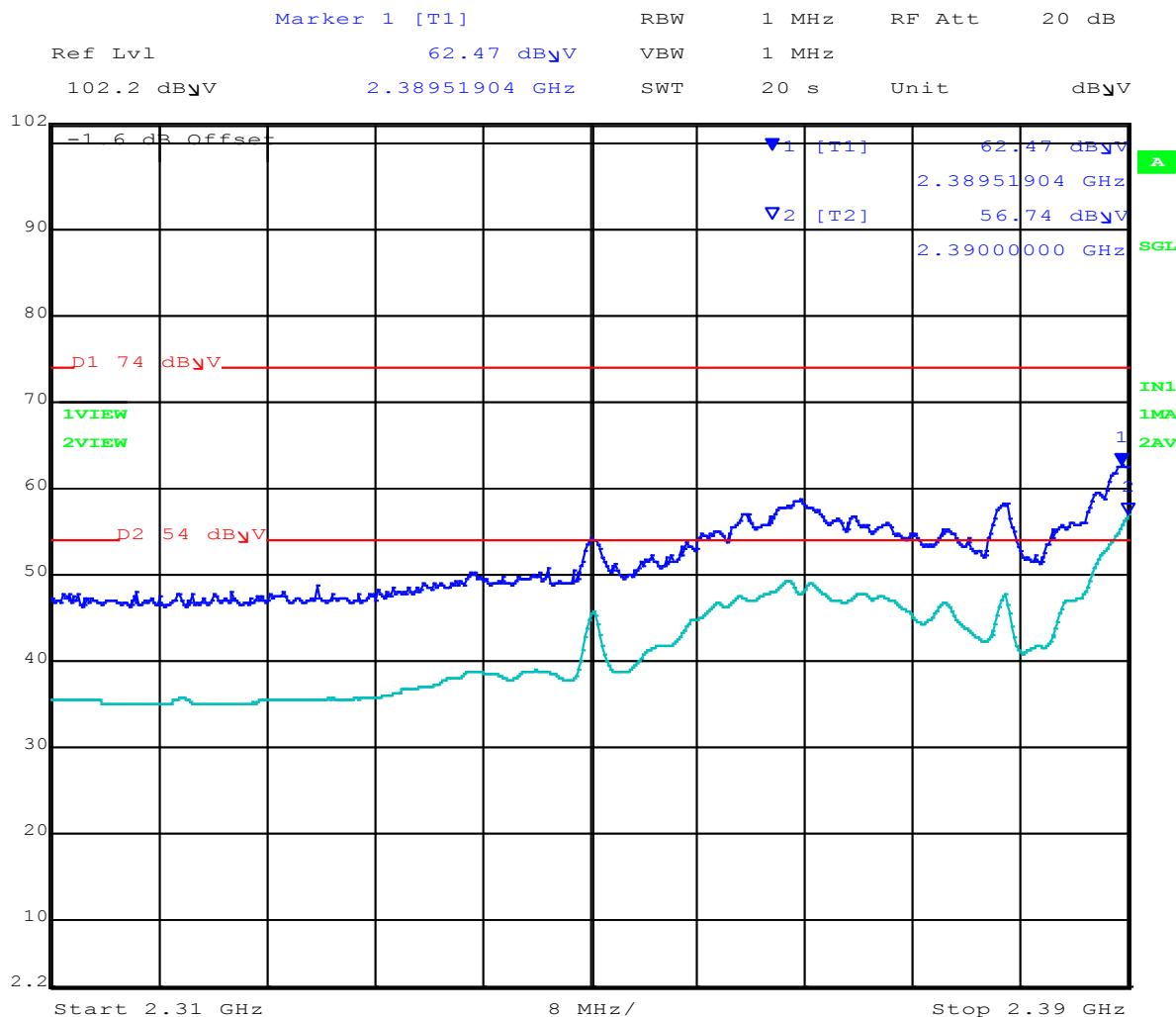
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Antenna AK-110 : 2483.5 MHz Restricted Band-Edge



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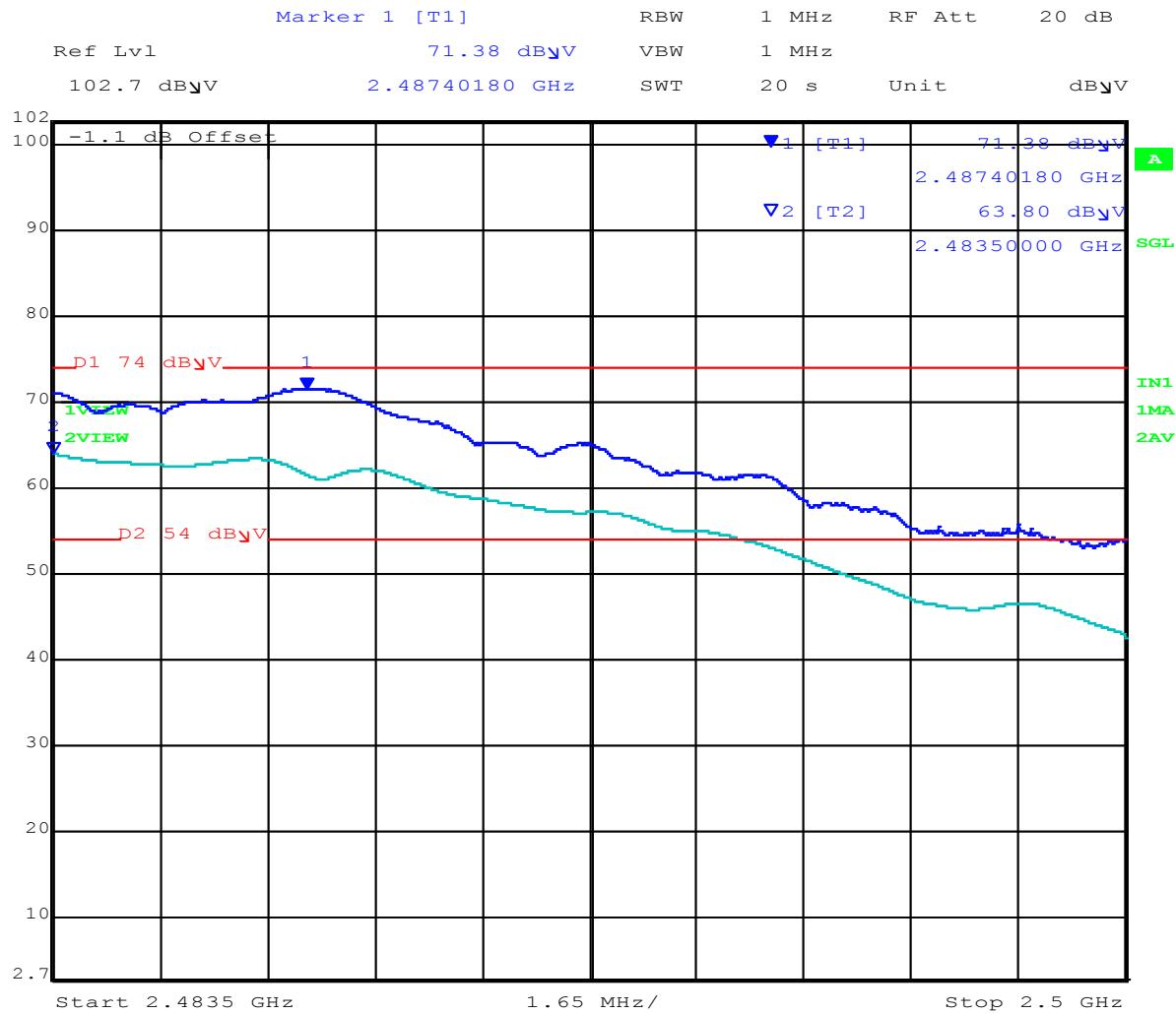
Antenna AK-210-10 : 2390 MHz Restricted Band-Edge



Date: 28.MAR.2014 14:12:40

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Antenna AK-210-10 : 2483.5 MHz Restricted Band-Edge



Date: 28.MAR.2014 14:14:12

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8.6 Radiated Digital Emissions

Standard Reference

FCC, Part 15 Subpart B §15.109

Industry Canada ICES-003 §5

Test Procedure

Testing was performed in a 3-meter semi-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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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.

$$\mathbf{FS = R + AF + CORR - FO}$$

FS = Field Strength

R = Measured Spectrum analyzer Input Amplitude

AF = Antenna Factor

$$\mathbf{CORR = Correction\ Factor = CL - AG + NFL}$$

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

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

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

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

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

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

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Specification

Radiated Spurious Emissions – Digital Apparatus

FCC, Part 15 Subpart B §15.109

A representative type or model of each digital apparatus shall be tested in accordance with the measurement methods described in FCC Part 15; Subpart A - General and FCC Subpart B – Unintentional Radiators.

Industry Canada ICES-003

A representative type or model of each digital apparatus shall be tested in accordance with the measurement method described in the publication referred to in Section 7.1 [Canadian Standards Association Standard CAN/CSA-CEI/IEC CISPR 22:02, "Limits and Methods of Measurement of Radio Disturbance Characteristics of Information Technology Equipment."].

FCC, Part 15 Subpart B §15.109 Spurious Emissions Limits

Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values.

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

Field Strength of radiated emissions for a Class A digital device are as follows.

Frequency (MHz)	Field Strength (μ V/m)	Field Strength (dB μ V/m)	Measurement Distance (meters)
30-88	100	49.5	3
88-216	150	54.0	3
216-960	200	57.0	3
Above 960	500	60.0	3

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ICES-003 §5 Spurious Emissions Limits

Class A Digital Device: The field intensity of radio noise emissions that are radiated from a Class A digital apparatus shall not exceed the limits specified in Table 5 of the publication referred to in Section 7.1, within the indicated frequency range.

Frequency range MHz	Quasi-peak limits dB(μ V/m) @ 10m	Quasi-peak limits dB(μ V/m) @ 3m
30 to 230	40	50.5
230 to 1 000	47	57.5
Note 1	The lower limit shall apply at the transition frequency.	
Note 2	Additional provisions may be required for cases where interference occurs	

Class B Digital Device: The field intensity of radio noise emissions that are radiated from a Class B digital apparatus shall not exceed the limits specified in Table 6 of the publication referred to in Section 7.1, within the indicated frequency range.

Frequency range (MHz)	Quasi-peak limits dB(μ V/m) @ 10m	Quasi-peak limits dB(μ V/m) @ 3m
30 to 230	30	40.5
230 to 1 000	37	47.5
Note 1	The lower limit shall apply at the transition frequency.	
Note 2	Additional provisions may be required for cases where interference occurs	

Laboratory Measurement Uncertainty for Spectrum Measurement

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

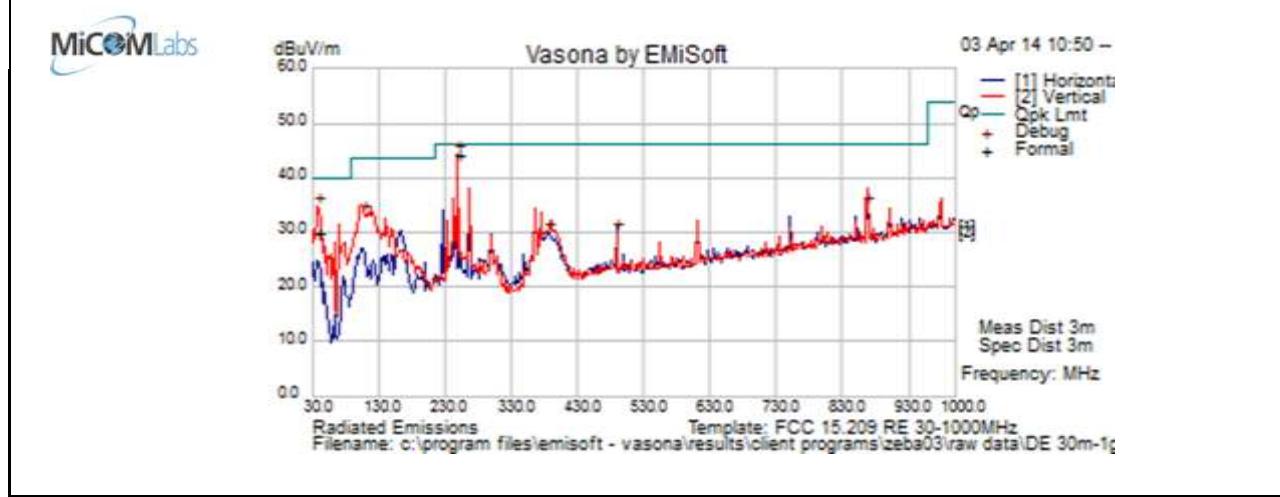
Traceability

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

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8.6.1 Measurement Results for Radiated Spurious Emissions – Digital Apparatus

Test Freq.	2441.75 MHz	Engineer	SB
Variant	Digital Emissions	Temp (°C)	25
Freq. Range	30 MHz - 1000 MHz	Rel. Hum.(%)	33
Power Setting	High Power	Press. (mBars)	1008
Antenna	AK-210-10		
Test Notes 1	AC/DC power Supply on table; Ethernet Cable connected to laptop		
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	
250.025	58.4	4.9	-19.0	44.3	Quasi Max	H	103	51	46.0	-1.7	Pass		
39.048	43.0	3.6	-16.7	29.9	Quasi Max	V	109	246	40.0	-10.2	Pass		
387.445	39.6	5.4	-15.2	29.8	Peak [Scan]	V	108	246	46.0	-16.2	Pass		
868.080	35.8	7.1	-8.2	34.8	Peak [Scan]	V	108	246	46.0	-11.3	Pass		
109.540	48.0	4.1	-18.9	33.2	Peak [Scan]	V	108	246	43.5	-10.3	Pass		
488.783	37.0	5.8	-12.9	29.9	Peak [Scan]	V	108	246	46.0	-16.1	Pass		
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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8.7 Conducted Disturbance at Mains Terminal (150 kHz – 30 MHz)

Standard Reference

FCC, Part 15 Subpart C §15.107
Industry Canada ICES-003 §5.3

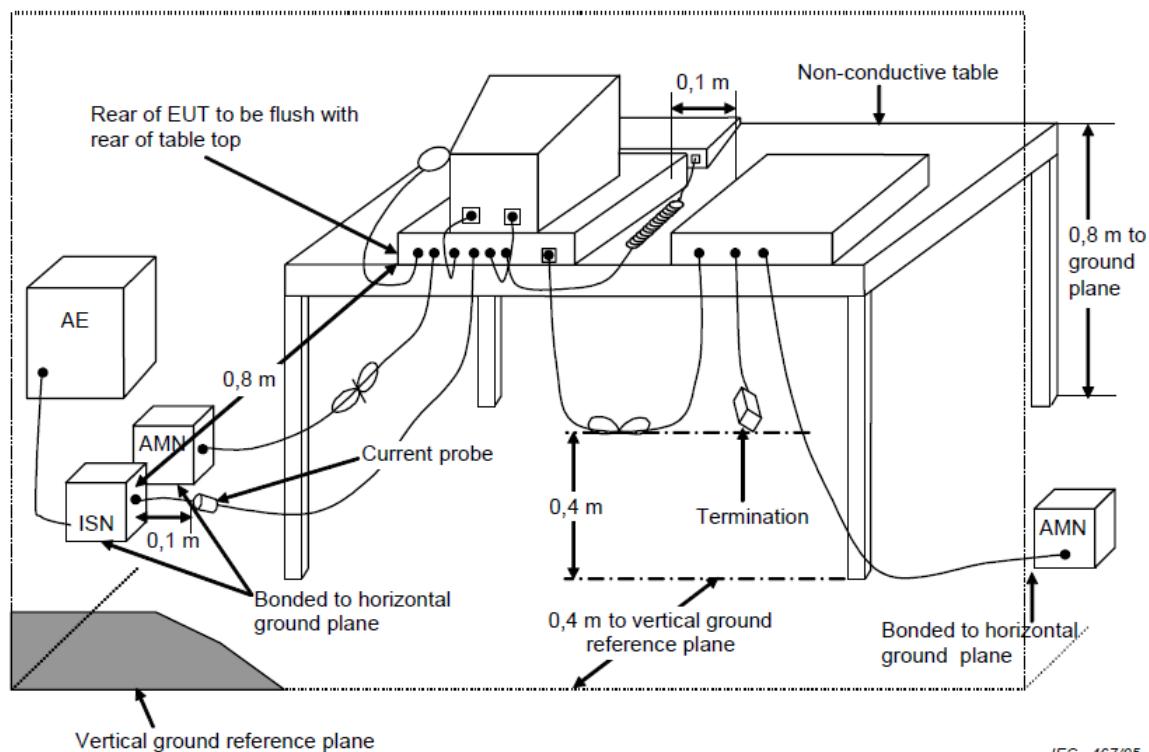
Test Procedure

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

If the average limit is met when using a quasi-peak detector receiver, the EUT shall be deemed to meet both limits and measurement with the average detector receiver is unnecessary.

If the reading of the measuring receiver shows fluctuations close to the limit, the reading shall be observed for at least 15 s at each measurement frequency; the higher reading shall be recorded with the exception of any brief isolated high reading which shall be ignored.

Test Measurement Set up



Measurement set up for Conducted Disturbance at Mains Terminals

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Specification

Conducted Disturbance at Mains Terminal – Digital Apparatus

FCC, Part 15 Subpart B §15.107

(a) Except for Class A digital devices, for equipment 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 μ H/50 ohms line impedance stabilization network (LISN). 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. The lower limit applies at the band edges.

(b) For a Class A digital device 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 μ H/50 ohms LISN. 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. The lower limit applies at the boundary between the frequency ranges.

Industry Canada ICES-003

The voltage of radio noise emissions that are conducted along the power supply lines of a Class A digital apparatus shall not exceed the limits specified in Table 1 of the publication referred to in Section 7.1 [Canadian Standards Association Standard CAN/CSA-CEI/IEC CISPR 22:02, "Limits and Methods of Measurement of Radio Disturbance Characteristics of Information Technology Equipment."], within the indicated frequency range.

The voltage of radio noise emissions that are conducted along the power supply lines of a Class B digital apparatus shall not exceed the limits specified in Table 2 of the publication referred to in Section 7.1 [Canadian Standards Association Standard CAN/CSA-CEI/IEC CISPR 22:02, "Limits and Methods of Measurement of Radio Disturbance Characteristics of Information Technology Equipment."], within the indicated frequency range.

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FCC, Part 15 Subpart B §15.107 & Industry Canada ICES-003 Limits

Limits for conducted disturbance at the mains ports of class B ITE

Frequency of emission (MHz)	Quasi-peak dBuV	Average dBuV
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50
Note 1	* Decreases with the logarithm of the frequency	
Note 2	* The lower limit applies at the boundary between frequency ranges	

Limits for conducted disturbance at the mains ports of class A ITE

Frequency of emission (MHz)	Quasi-peak dBuV	Average dBuV
0.15–0.5	79	66
0.5–30	73	60
Note 1	* The lower limit shall apply at the transition frequency.	

Laboratory Measurement Uncertainty for Conducted Emissions

Measurement uncertainty	±2.64 dB
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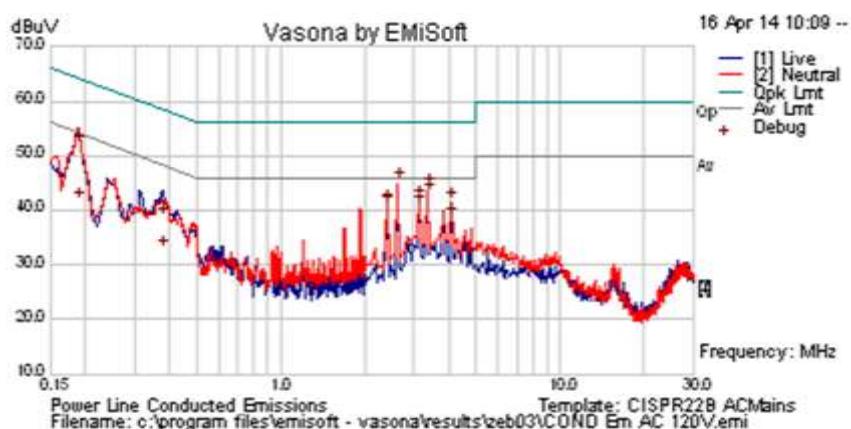
Traceability

Method	Test Equipment Used
Work instruction WI-EMC-01	0158, 0184, 0193, 0190, 0293, 0307

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8.7.1 Conducted Disturbance at Mains Terminal (150 kHz – 30 MHz)

Test Freq.	N/A	Engineer	JMH
Variant	AC Line Emissions	Temp (°C)	20
Freq. Range	0.150 MHz - 30 MHz	Rel. Hum. (%)	35
Power Setting	NA	Press. (mBars)	1004
Antenna	N/A		
Test Notes 1	EUT Part # LOS-5000-00AA S/N M40491305Z14		
Test Notes 2	120V AC MEPOS AC/DC PS P/N SIDA25A-S11		

Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	Factors dB	Level dBuV	Measurement Type	Line	Limit dBuV	Margin dB	Pass /Fail	Comments
0.188	41.8	9.9	0.1	51.8	Quasi Peak	Neutral	64.12	-12.3	Pass	
0.188	31.6	9.9	0.1	41.6	Average	Neutral	54.12	-12.6	Pass	
0.380	22.9	9.9	0.1	32.9	Average	Live	48.28	-15.4	Pass	
0.380	28.7	9.9	0.1	38.7	Quasi Peak	Live	58.28	-19.6	Pass	
2.409	31.1	10.1	0.1	41.3	Quasi Peak	Live	56	-14.7	Pass	
2.409	30.7	10.1	0.1	40.9	Average	Live	46	-5.1	Pass	
2.649	35.1	10.1	0.1	45.4	Quasi Peak	Live	56	-10.6	Pass	
2.649	35.0	10.1	0.1	45.2	Average	Live	46	-0.8	Pass	
3.132	31.7	10.1	0.2	42.0	Quasi Peak	Neutral	56	-14.1	Pass	
3.132	30.6	10.1	0.2	40.9	Average	Neutral	46	-5.1	Pass	
3.371	33.8	10.1	0.2	44.1	Quasi Peak	Neutral	56	-11.9	Pass	
3.371	33.0	10.1	0.2	43.2	Average	Neutral	46	-2.8	Pass	
4.094	28.5	10.1	0.2	38.8	Average	Neutral	46	-7.2	Pass	
4.094	31.3	10.1	0.2	41.6	Quasi Peak	Neutral	56	-14.4	Pass	
<hr/>										
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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9 PHOTOGRAPHS

9.1 Conducted RF Measurement Set Up



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9.2 Radiated Spurious Emissions Below 1 GHz

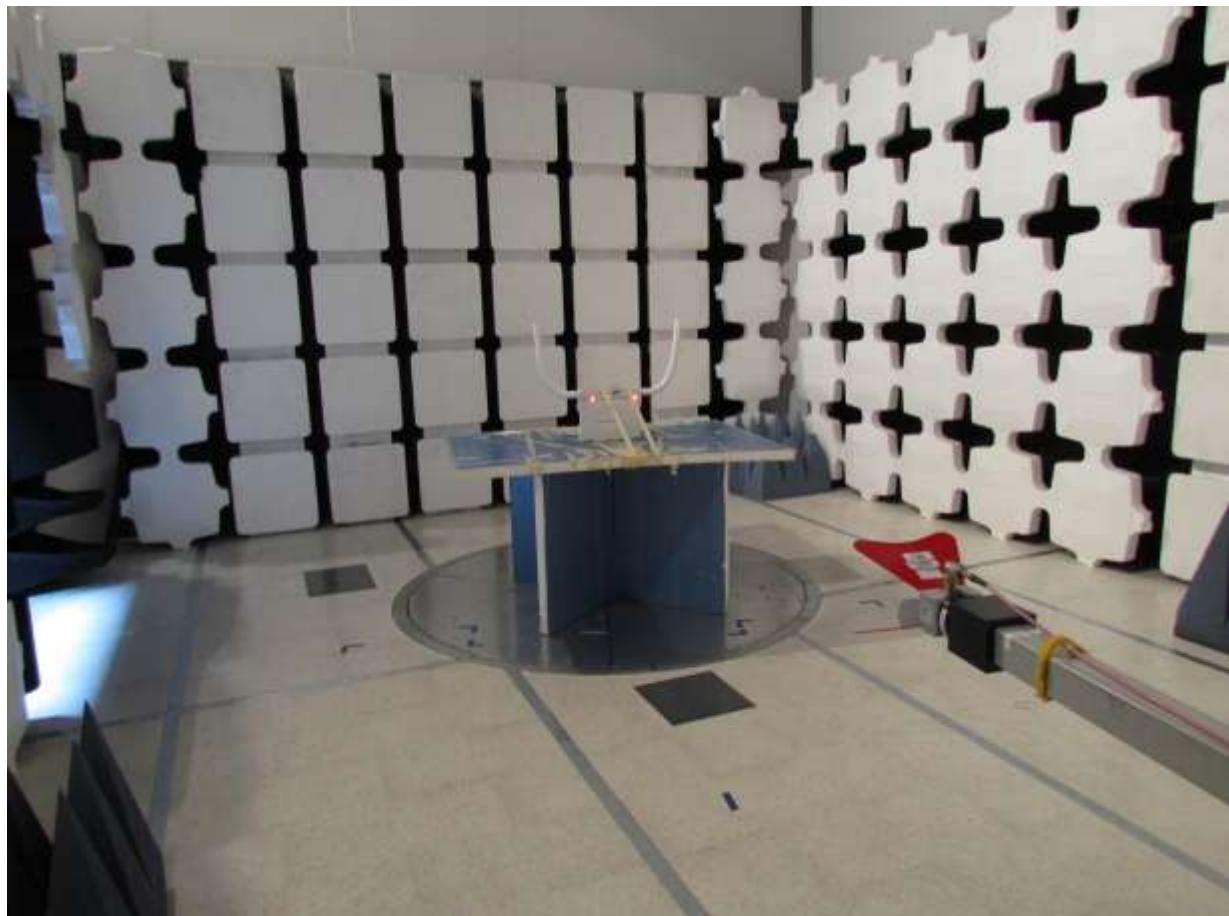
Antenna AK-210-10



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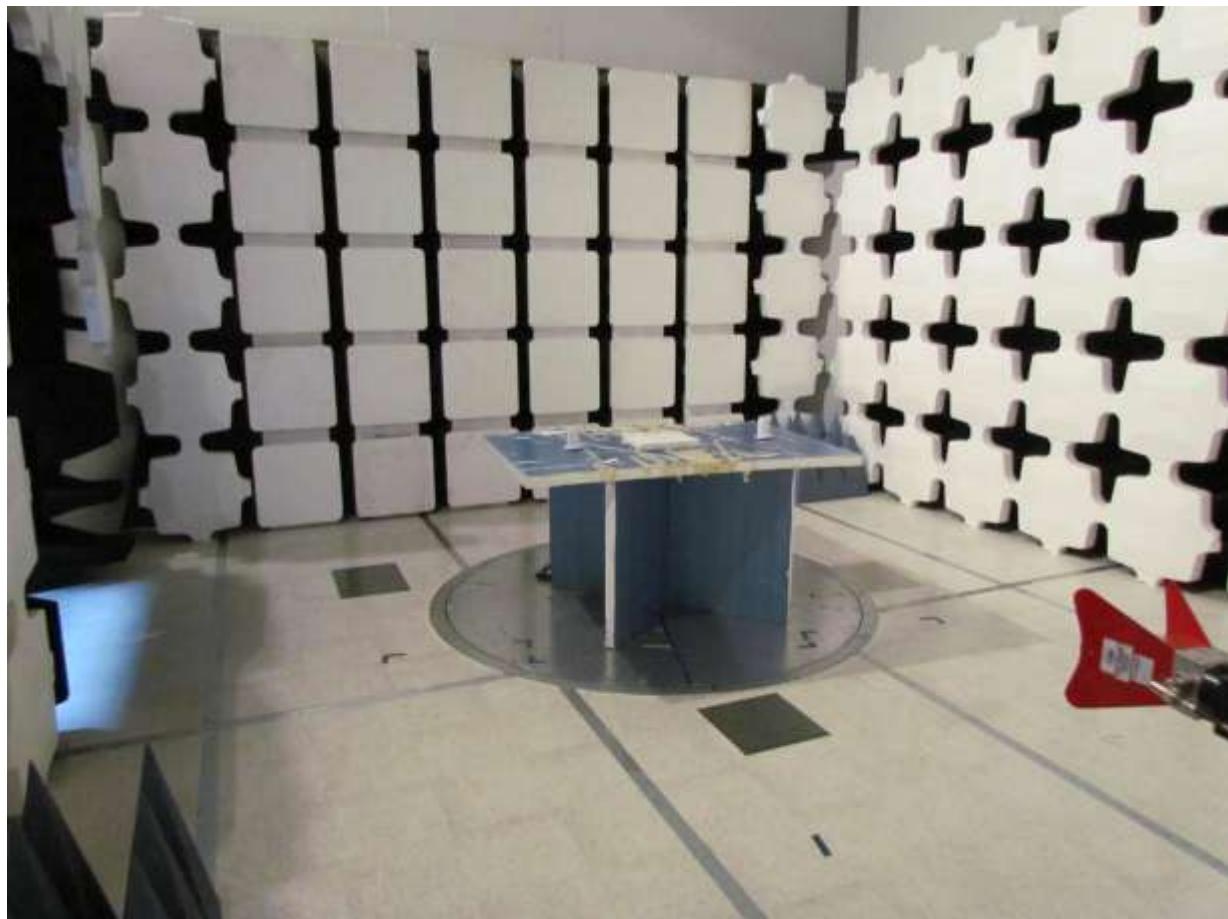
9.3 Radiated Spurious Emissions Above 1 GHz

Antenna AK-210-10



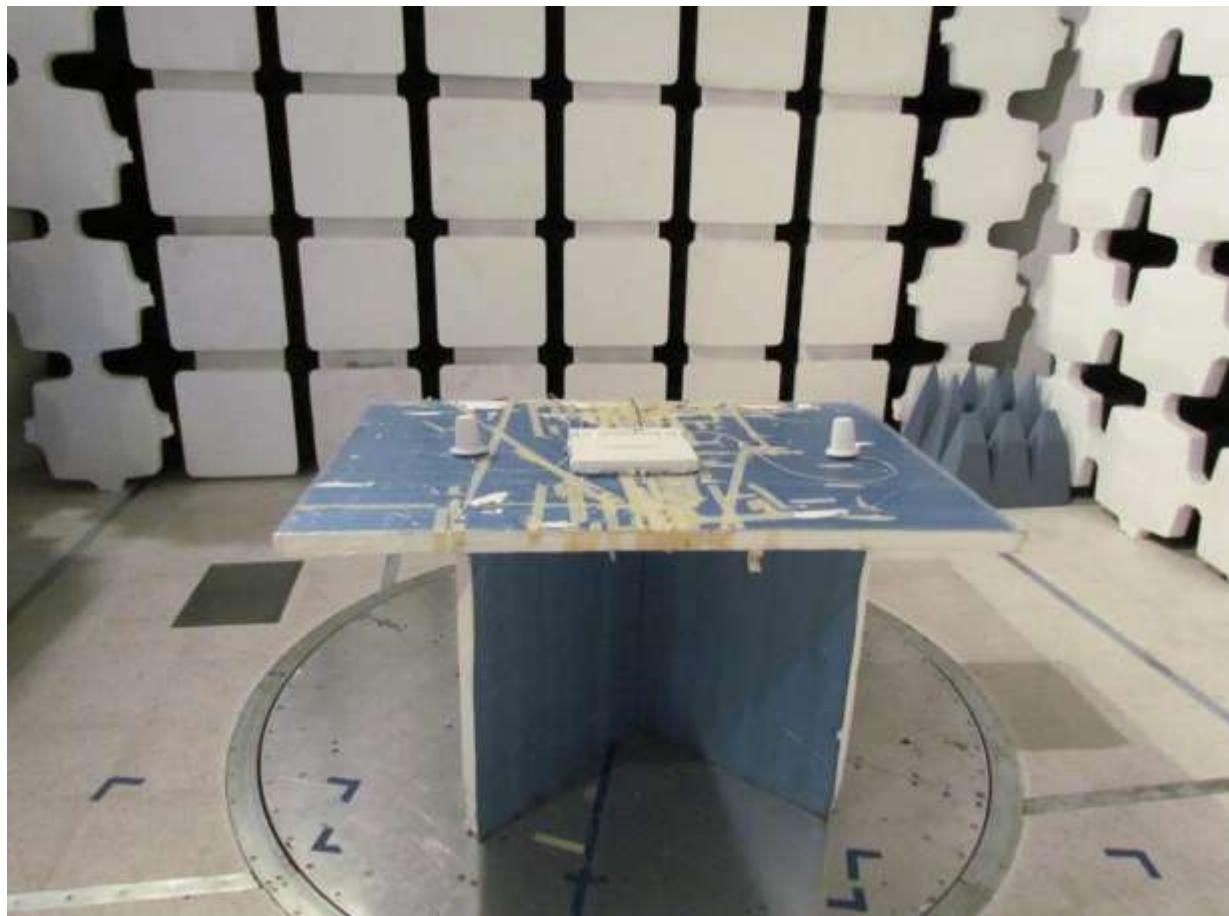
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Antenna AK-110



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Antenna AK-110



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9.4 ac Wireline Emissions



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10 TEST EQUIPMENT DETAILS

Asset #	Instrument	Manufacturer	Model #	Serial #
0072	Signal Generator	Hewlett Packard	HP 83640A	2927A00105
0075	Environmental Chamber	Thermatron	SE-300-2-2	27946
0338	Antenna (30M-3GHz)	Sunol Sciences	JB3	A052907
0083	Coupler	Hewlett Packard	HP 87301D	3116A00389
0287	EMI Receiver	Rhode & Schwartz	ESIB 40	100201
0335	Horn Antenna	The Electro-Mechanics Company	3117	00066580
0116	Power Sensor	Hewlett Packard	8485A	3318A19694
0117	Power Sensor	Hewlett Packard	8487D	3318A00371
0134	Amplifier	ComPower	PA-122	181910
0158	Barometer /Thermometer	Control Co.	4196	E2844
0193	EMI Receiver	Rhode & Schwartz	ESI 7	838496/007
0223	Power Meter	Hewlett Packard	HP EPM-442A	US37480256
0252	K-Cable	Megaphase	Sucoflex 104	Unknown
0253	K-Cable	Megaphase	Sucoflex 104	Unknown
0256	K-Cable	Megaphase	Sucoflex 104	Unknown
0251	K-Cable	Megaphase	Sucoflex 104	Unknown
0305	20M-2GHz Amplifier	ML	ML001	001
0310	2m SMA Cable	Micro-Coax	UFA210A-0-0787-3G03G0	209089-001
0312	3m SMA Cable	Micro-Coax	UFA210A-1-1181-3G0300	209092-001
0313	Coupler	Hewlett Packard	86205A	3140A01285
0314	30 dB N-Type Attenuator	ARRA	N944-30	1623
Dipole	20MHz-1GHz Dipole Antennas	EMCO	3121C	9009-505

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11 APPENDIX

A. SUPPORTING INFORMATION

A.1. CONDUCTED TEST PLOTS

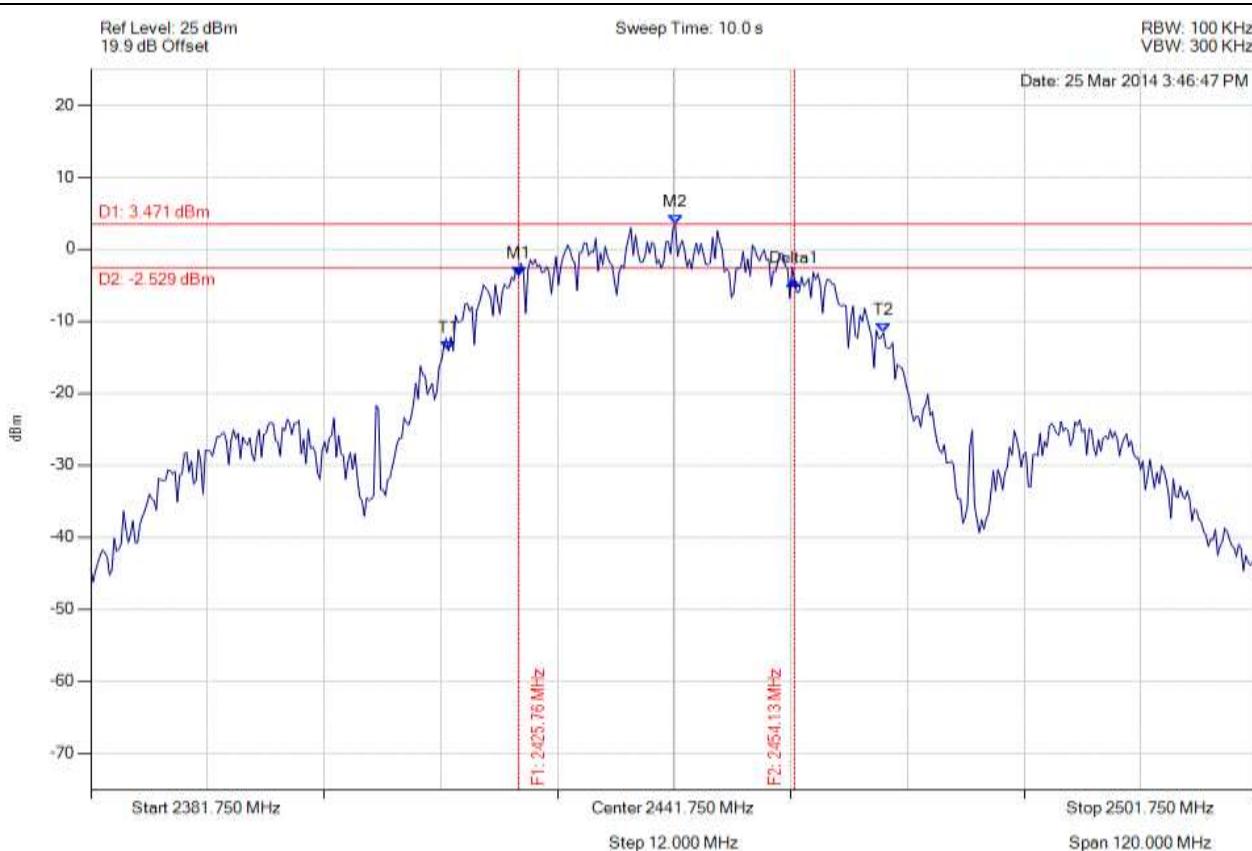
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A.1.1. 6 dB & 99% Bandwidth



6 dB & 99% BANDWIDTH

Variant: DSSS, Channel: 2441.75 MHz, Chain a, Temp: Ambient, Voltage: 48 Vdc



Analyser Setup	Marker : Frequency : Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2425.758 MHz : -3.647 dBm M2 : 2441.870 MHz : 3.471 dBm Delta1 : 28.377 MHz : -0.698 dB T1 : 2418.544 MHz : -14.107 dBm T2 : 2463.273 MHz : -11.587 dBm OBW : 44.729 MHz	Measured 6 dB Bandwidth: 28.377 MHz Limit: ≥500.0 kHz Margin: -27.88 MHz

[Back to the Matrix](#)

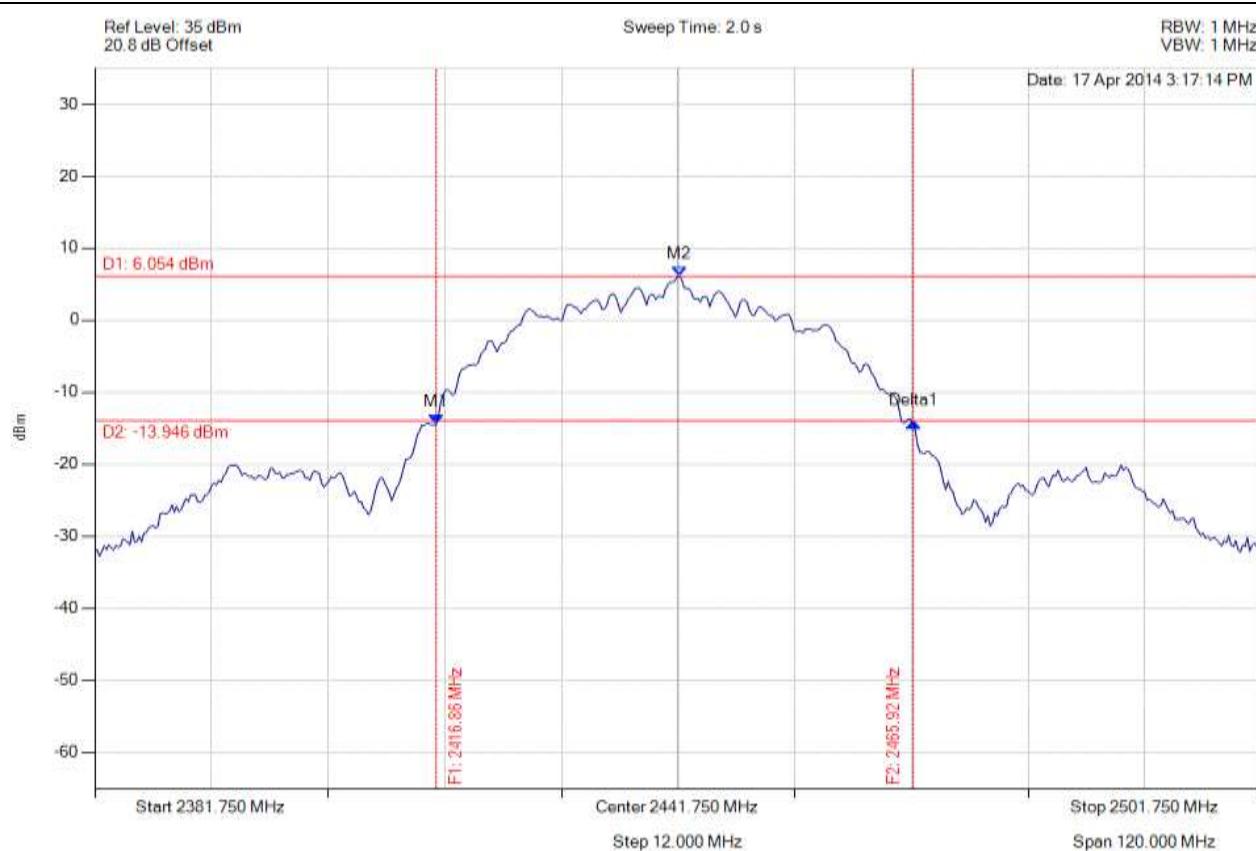
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A.1.2. Peak Output Power



PEAK OUTPUT POWER

Variant: DSSS, Channel: 2441.75 MHz, Chain a, Temp: Ambient, Voltage: Vdc



Analyser Setup	Marker : Frequency : Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 30 Trace Mode = VIEW	M1 : 2416.860 MHz : -14.412 dBm M2 : 2441.870 MHz : 6.054 dBm Delta1 : 49.058 MHz : 0.159 dB	Channel Power: 17.09 dBm Limit: 30.00 dBm Margin: -12.91 dB

[Back to the Matrix](#)

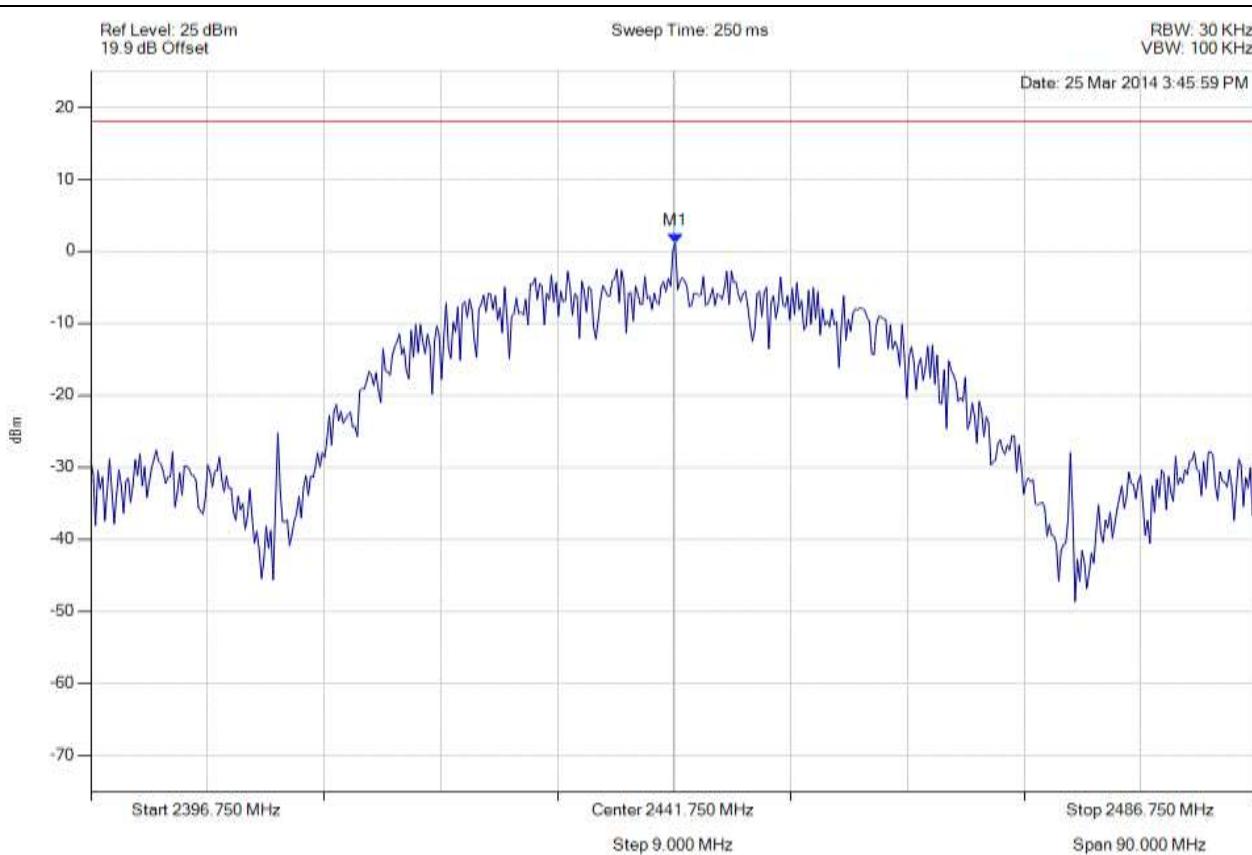
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A.1.3. Power Spectral Density



POWER SPECTRAL DENSITY - PEAK

Variant: DSSS, Channel: 2441.75 MHz, Chain a, Temp: Ambient, Voltage: 48 Vdc



Analyser Setup	Marker : Frequency : Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2441.840 MHz : 1.144 dBm	Limit: ≤ 18.000 dBm Margin: -16.86 dB

[Back to the Matrix](#)

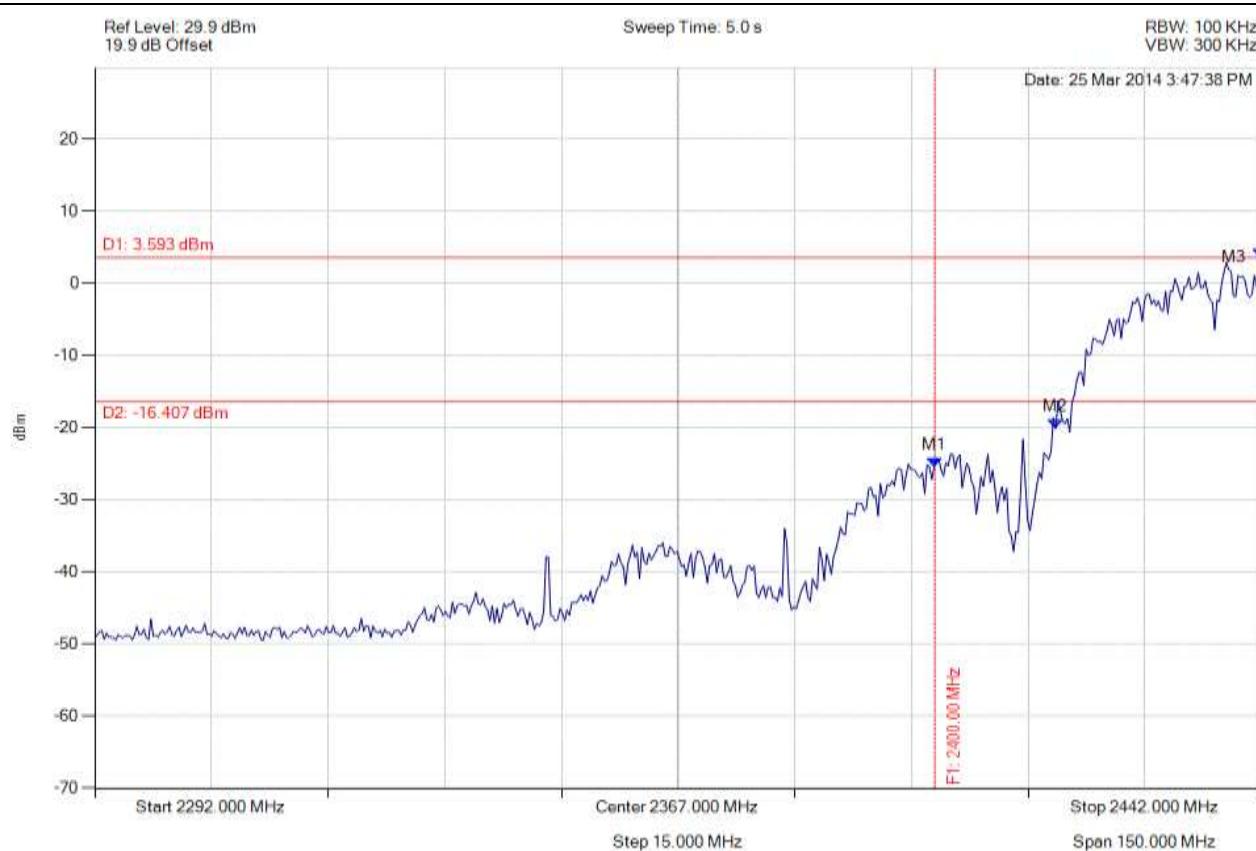
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A.1.4. Conducted Spurious Emissions



CONDUCTED LOW BAND-EDGE EMISSION - PEAK

Variant: DSSS, Channel: 2441.75 MHz, Chain a, Temp: Ambient, Voltage: 48 Vdc



Analyser Setup	Marker : Frequency : Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2400.000 MHz : -25.489 dBm M2 : 2415.547 MHz : -20.148 dBm M3 : 2442.000 MHz : 3.593 dBm	Channel Frequency: 2441.75 MHz

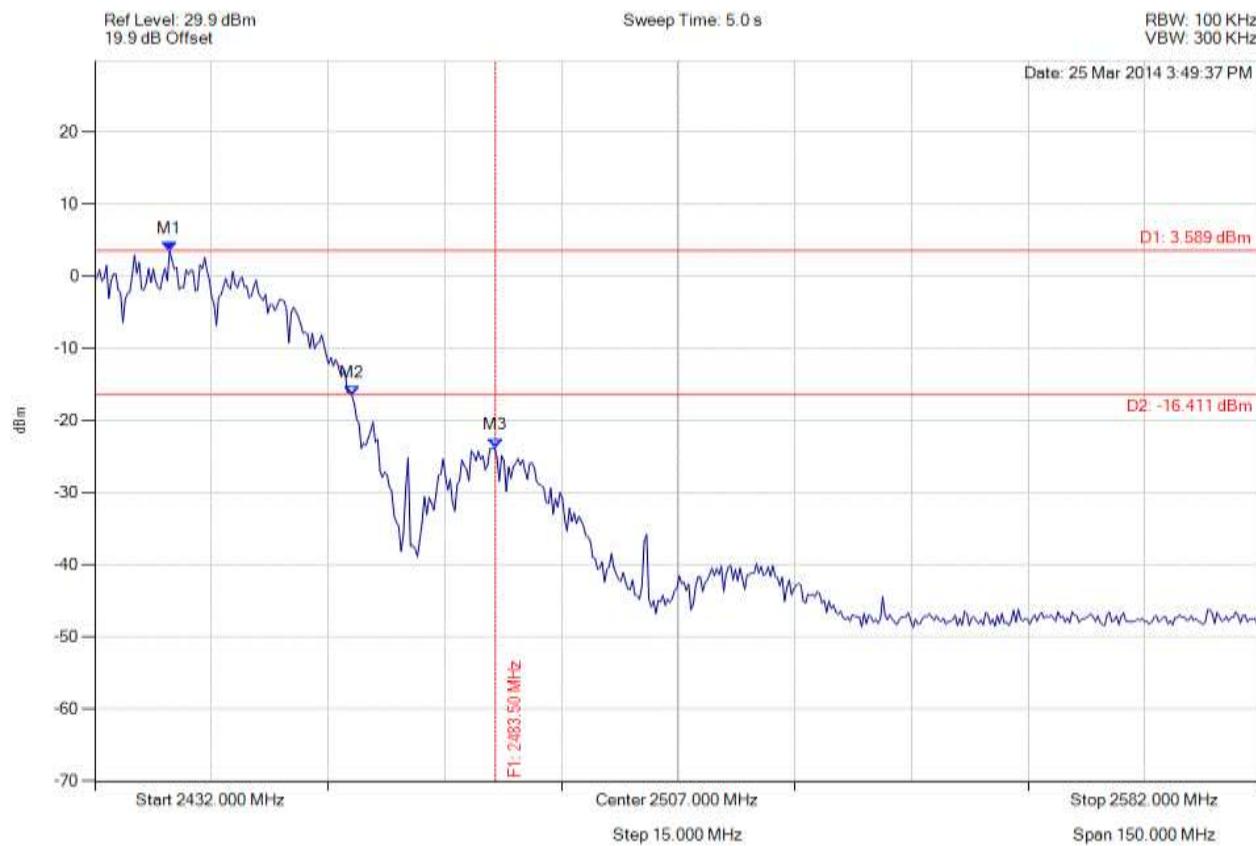
[Back to the Matrix](#)

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CONDUCTED HIGH BAND-EDGE EMISSION - PEAK

Variant: DSSS, Channel: 2441.75 MHz, Chain a, Temp: Ambient, Voltage: 48 Vdc



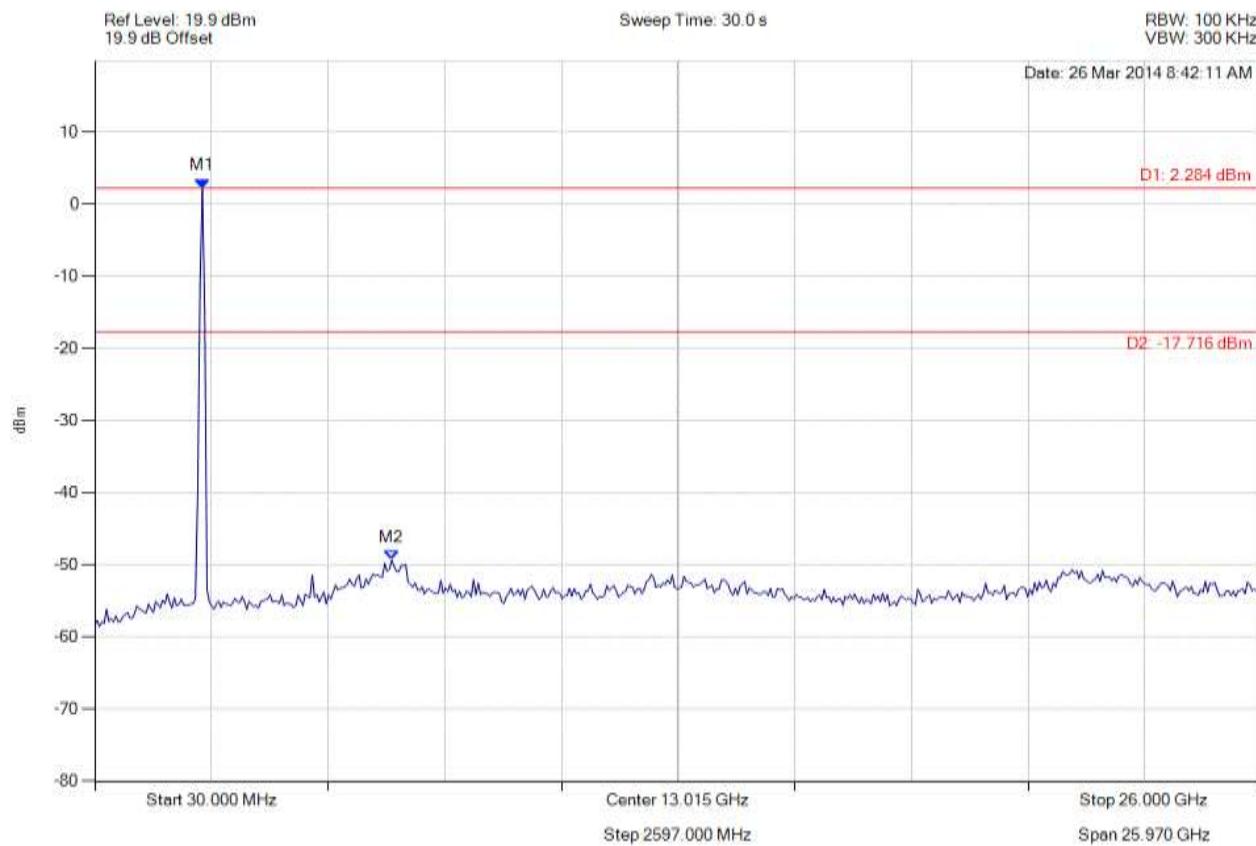
Analyser Setup	Marker : Frequency : Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2441.619 MHz : 3.589 dBm M2 : 2465.066 MHz : -16.490 dBm M3 : 2483.500 MHz : -23.740 dBm	Channel Frequency: 2441.75 MHz

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CONDUCTED SPURIOUS EMISSIONS - PEAK

Variant: DSSS, Channel: 2441.75 MHz, Chain a, Temp: Ambient, Voltage: Vdc



Analyser Setup	Marker : Frequency : Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 10 Trace Mode = VIEW	M1 : 2424.028 MHz : 2.284 dBm M2 : 6639.599 MHz : -49.373 dBm	Limit: -17.72 dBm Margin: -31.65 dB

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