

Company: Shoof Technologies, Inc.

Test of: Strix Wireless Tag

To: FCC CFR 47 PART 15.247 & ISED RSS-247

Report No.: SHOO03-U3 Rev A

COMPLETE TEST REPORT



COMPLETE TEST REPORT

FROM



Test of: Shoof Technologies, Inc. Strix Wireless Tag

To: FCC CFR 47 PART 15.247 & ISED RSS-247

Test Report Serial No.: SHOO03-U3 Rev A

This report supersedes: NONE

Applicant: Shoof Technologies, Inc.
440 N. Wolfe Rd, Suite E112
Sunnyvale, California 94085
USA

Product Function; Wireless Tag

Issue Date; 23rd January 2019

This Test Report is Issued Under the Authority of:

MiCOM Labs, Inc.
575 Boulder Court
Pleasanton California 94566
USA
Phone: +1 (925) 462-0304
Fax: +1 (925) 462-0306
www.micomlabs.com



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 ISO/IEC 17025:2005. 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>



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 April 2017).

Presented this 14th day of May 2018.


President and CEO
For the Accreditation Council
Certificate Number 2381.01
Valid to November 30, 2019

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

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1.2. RECOGNITION

MiCOM Labs, Inc has widely recognized wireless testing capabilities. Our international recognition includes Conformity Assessment Body designation by APEC MRA countries. MiCOM Labs test reports are accepted globally.

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 4143A-3
Japan	MIC (Ministry of Internal Affairs and Communication) VCCI	CAB	APEC MRA 2	RCB 210
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	

EU MRA – European Union Mutual Recognition Agreement.

NB – Notified Body

APEC MRA – Asia Pacific Economic Community Mutual Recognition Agreement. 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

1.3. PRODUCT CERTIFICATION

MiCOM Labs, Inc. is an accredited Product Certification Body per the international standard ISO/IEC 17065:2012. 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>



Accredited Product Certification Body

A2LA has accredited

MiCOM LABS

Pleasanton, CA

This product certification body is accredited in accordance with the recognized International Standard ISO/IEC 17065:2012 Requirements for bodies certifying products, processes and services. This product certification body also meets the A2LA R322 – Specific Requirements – Notified Body Accreditation Requirements and A2LA R308 - Specific Requirements - ISO/IEC 17065 - Telecommunication Certification Body Accreditation Program. This accreditation demonstrates technical competence for a defined scope and the operation of a management system.

Presented this 14th day of May 2018



President and CEO
For the Accreditation Council
Certificate Number 2381.02
Valid to November 30, 2019



For the product certification schemes to which this accreditation applies, please refer to the organization's Product Certification Scope of Accreditation.

United States of America – Telecommunication Certification Body (TCB)
Industry Canada – Certification Body, CAB Identifier – US0159

Europe – Notified Body (NB), NB Identifier - 2280

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

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2. DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft	11th January 2019	Draft report for client review.
Rev A	23 rd January 2019	Initial release
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In the above table the latest report revision will replace all earlier versions.

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Title: Shoof Technologies, Inc. Strix Wireless Tag
To: FCC PART 15.247 & ISED RSS-247
Serial #: SHOO03-U3 Rev A
Issue Date: 23rd January 2019
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3. TEST RESULT CERTIFICATE

Manufacturer: Shoof Technologies, Inc.
440 N. Wolfe Rd, Suite E112
Sunnyvale
California 94085 USA

Tested By: MiCOM Labs, Inc.
575 Boulder Court
Pleasanton
California 94566 USA

Model: Strix Wireless Tag

Telephone: +1 925 462 0304

Type Of Equipment: Wireless Tag

Fax: +1 925 462 0306

S/N's: FCC#1, FCC#2

Test Date(s): 13 - 20 December 2018

Website: www.micomlabs.com

STANDARD(S)

FCC CFR 47 PART 15.247 & ISED RSS-247

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.

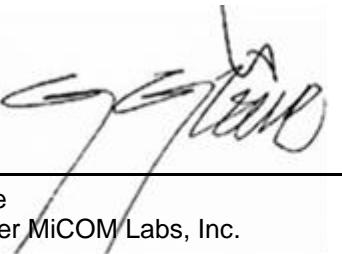
Notes:

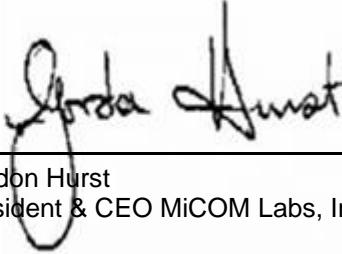
1. This document reports conditions under which testing was conducted and the results of testing performed.
2. Details of test methods used have been recorded and kept on file by the laboratory.
3. Test results apply only to the item(s) tested.

Approved & Released for MiCOM Labs, Inc. by:



TESTING CERT #2381.01


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	KDB 558074 D01 v05	24th August 2018	Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices operating under section 15.247 of the FCC Rules.
II	A2LA	August 2018	R105 - Requirement's When Making Reference to A2LA Accreditation Status
III	ANSI C63.10	2013	American National Standard for Testing Unlicensed Wireless Devices
IV	ANSI C63.4	2014	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 32	2015	Electromagnetic compatibility of multimedia equipment - Emission requirements
VI	ETSI TR 100 028	2001-12	Parts 1 and 2 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics
VII	FCC 47 CFR Part 15, Subpart B	2014	Title 47: Telecommunication PART 15—RADIO FREQUENCY DEVICES, SubPart B; Unintentional Radiators
VIII	FCC 47 CFR Part 15.247	2016	Radio Frequency Devices; Subpart C – Intentional Radiators
IX	FCC Public Notice DA 00-705	March 2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
X	ICES-003	Issue 6 Jan 2016; Updated April 2017	Information Technology Equipment (Including Digital Apparatus) – Limits and methods of measurement.
XI	M 3003	Edition 3 Nov.2012	Expression of Uncertainty and Confidence in Measurements
XII	RSS-247 Issue 2	Feb 2017	Digital Transmission Systems (DTSs), Frequency Hopping System (FHSs) and Licence-Exempt Local Area Network (LE-LEN) Devices
XIII	RSS-Gen Issue 5	April 2018	General Requirements for Compliance of Radio Apparatus
XIV	FCC 47 CFR Part 2.1033	2016	FCC requirements and rules regarding photographs and test setup diagrams.

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4.2. Test and Uncertainty Procedure

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.

5. PRODUCT DETAILS AND TEST CONFIGURATIONS

5.1. Technical Details

Details	Description
Purpose:	Test of the Shoof Technologies, Inc. Strix Wireless Tag to FCC CFR 47 PART 15.247 & ISED RSS-247 Radio Frequency Devices; Subpart C – Intentional Radiators
Applicant:	Shoof Technologies, Inc. 440 N. Wolfe Rd, Suite E112 Sunnyvale California 94085 USA
Manufacturer:	Shoof Technologies, Inc.
Laboratory performing the tests:	MiCOM Labs, Inc. 575 Boulder Court Pleasanton California 94566 USA
Test report reference number:	SHOO03-U3 Rev A
Date EUT received:	12 December 2018
Standard(s) applied:	FCC CFR 47 PART 15.247 & ISED RSS-247
Dates of test (from - to):	13 - 20 December 2018
No of Units Tested:	2
Product Family Name:	STRIX 3
Model(s):	520-020
Location for use:	Indoor/Outdoor
Declared Frequency Range(s):	902 - 928 MHz; 2400 - 2483.5 MHz;
Type of Modulation:	OQPSK
EUT Modes of Operation:	2400 - 2483.5 MHz:1200 kbps
Declared Nominal Output Power :	21.0 dBm
Transmit/Receive Operation:	Transceiver
Rated Input Voltage and Current:	DC 3.6V, 0.8 A
Operating Temperature Range:	-40 - +85 °C
ITU Emission Designator:	106KF1D
Equipment Dimensions:	1.315 X 3.426 in
Weight:	23 g
Hardware Rev:	500-015
Software Rev:	360-009

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5.2. Scope Of Test Program

Shoof Technologies, Inc. Strix Wireless Tag

The scope of the test program was to test the Shoof Technologies, Inc. Strix Wireless Tag in the frequency range 2400 - 2483.5 MHz for compliance against the following specification;

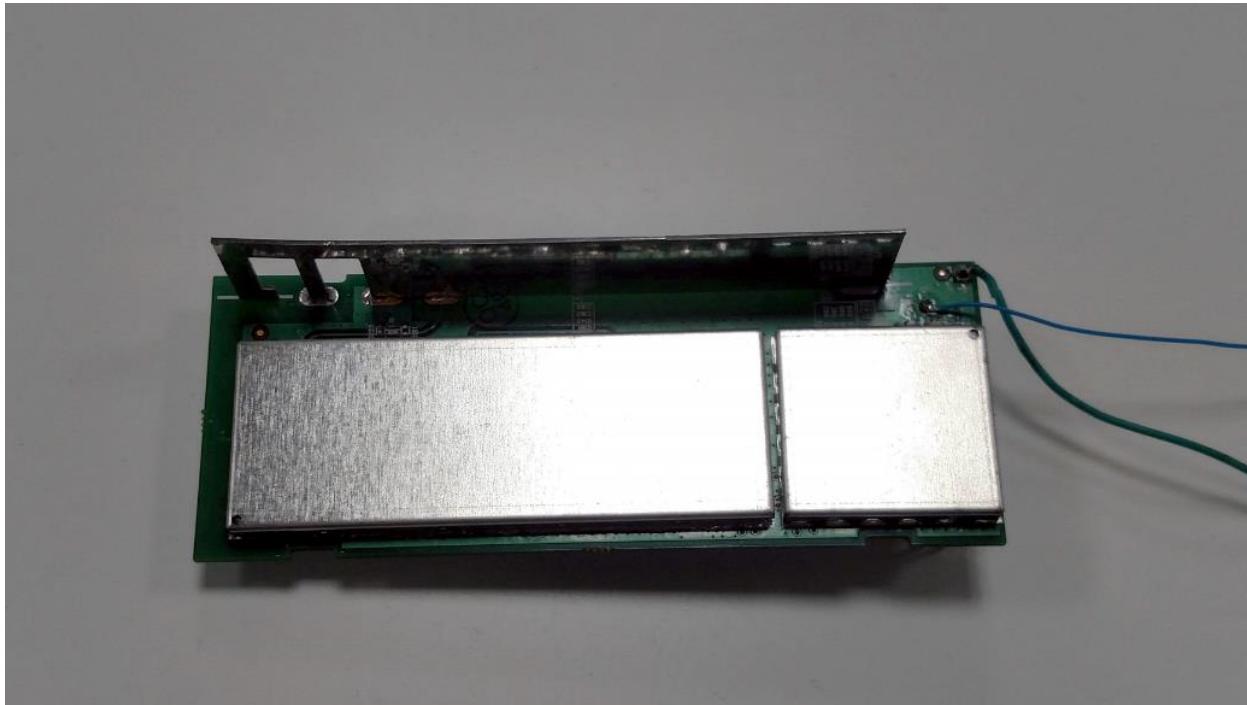
FCC CFR 47 Part 15 Subpart C 15.247 (FHSS)

Radio Frequency Devices; Subpart C – Intentional Radiators

ISED RSS-247

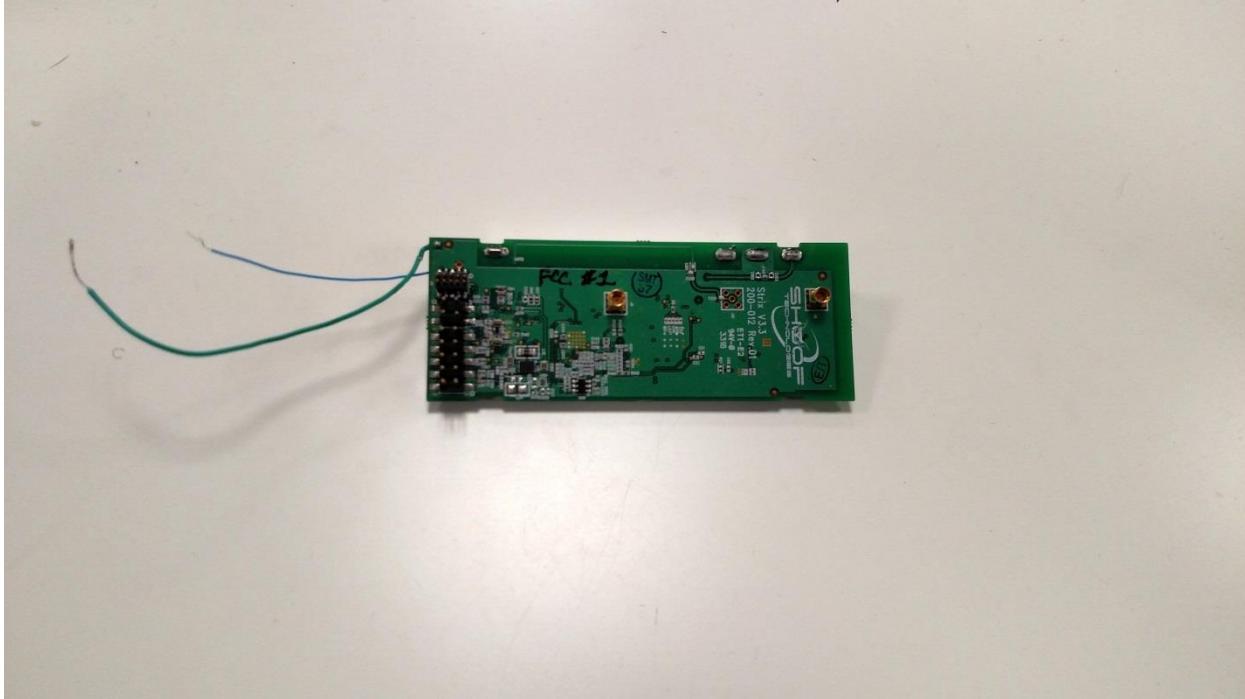
Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices

Shoof Technologies, Inc. Strix Wireless Tag (Top)



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Shoof Technologies, Inc. Strix Wireless Tag Bottom



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

Type	Description	Manf	Model	Serial No.
EUT	Wireless Inventory Tracking	Shoof Technologies	Strix Wireless Tag	FCC#1, FCC#2
Support	Laptop	Dell		
Support	DC Linear PS	HP	6274	

5.4. Antenna Details

Type	Manufacturer	Model	Family	Gain (dBi)	BF Gain	Dir BW	X-Pol	Frequency Band (MHz)
integral	Shoof Tech.	FHSS Antenna	f type	0.0	-	360	-	902 - 928
integral	Shoof Tech.	FHSS Antenna	f type	0.0	-	360	-	2400 - 2483.5
external	WP	WPANT30211-S1A	OMNI	3.0	-	360	-	902 - 928
external	WP	WPANT30211-S1A	OMNI	4.0	-	360	-	2400 - 2483.5

BF Gain - Beamforming Gain
 Dir BW - Directional BeamWidth
 X-Pol - Cross Polarization

5.5. Cabling and I/O Ports

USB to TTL cable

5.6. Test Configurations

Results for the following configurations are provided in this report:

Operational Mode(s) FSK and OQPSK	Data Rate with Highest Power MBit/s	Channel Frequency (MHz)		
		Low	Mid	High
2400 - 2483.5 MHz				
1200 kbps	2000	2401.00	2440.20	2479.40

5.7. Equipment Modifications

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

1. NONE

5.8. Deviations from the Test Standard

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

1. NONE

6. TEST SUMMARY

List of Measurements

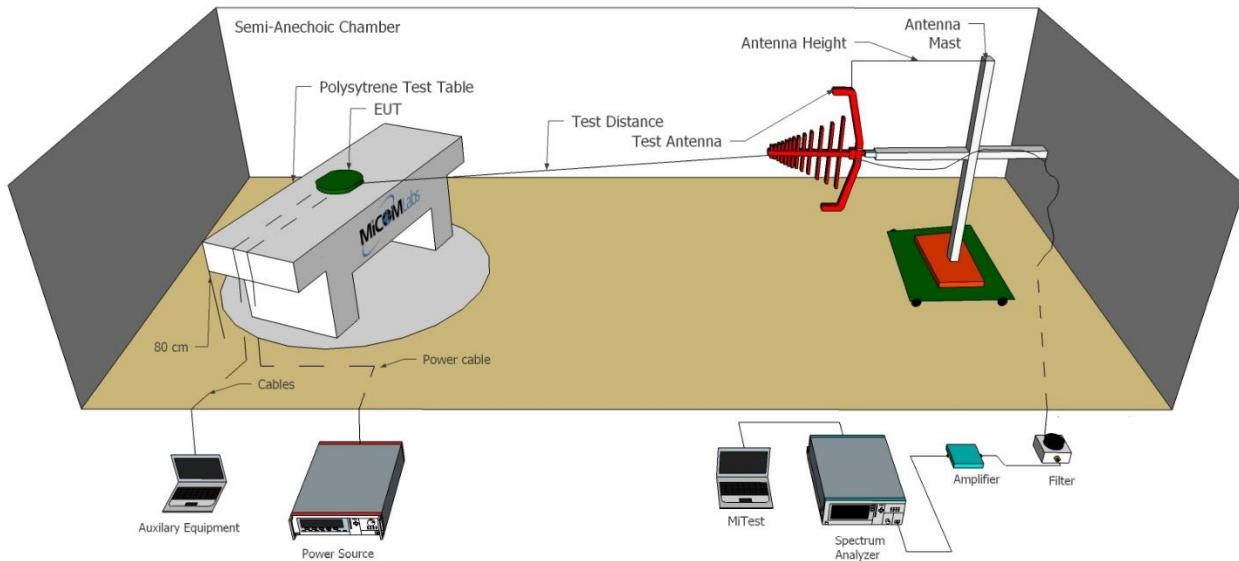
Test Header	Result	Data Link
20 dB & 99% Bandwidth	Complies	View Data
Frequency Hopping Tests	Complies	-
Number of Hopping Channels	Complies	View Data
Channel Separation and Channel Occupancy	Complies	View Data
Dwell Time	Complies	View Data
Output Power	Complies	View Data
Emissions	Complies	-
(1) Conducted Emissions	Complies	-
(i) Conducted Unwanted Spurious Emissions	Complies	View Data
(ii) Conducted Band-Edge Emissions	Complies	View Data
(2) Radiated Emissions	Complies	-
(i) TX Spurious & Restricted Band Emissions	Complies	View Data
(ii) Restricted Edge & Band-Edge Emissions	Complies	View Data
(3) Digital Emissions	Complies	View Data

7. TEST EQUIPMENT CONFIGURATION(S)

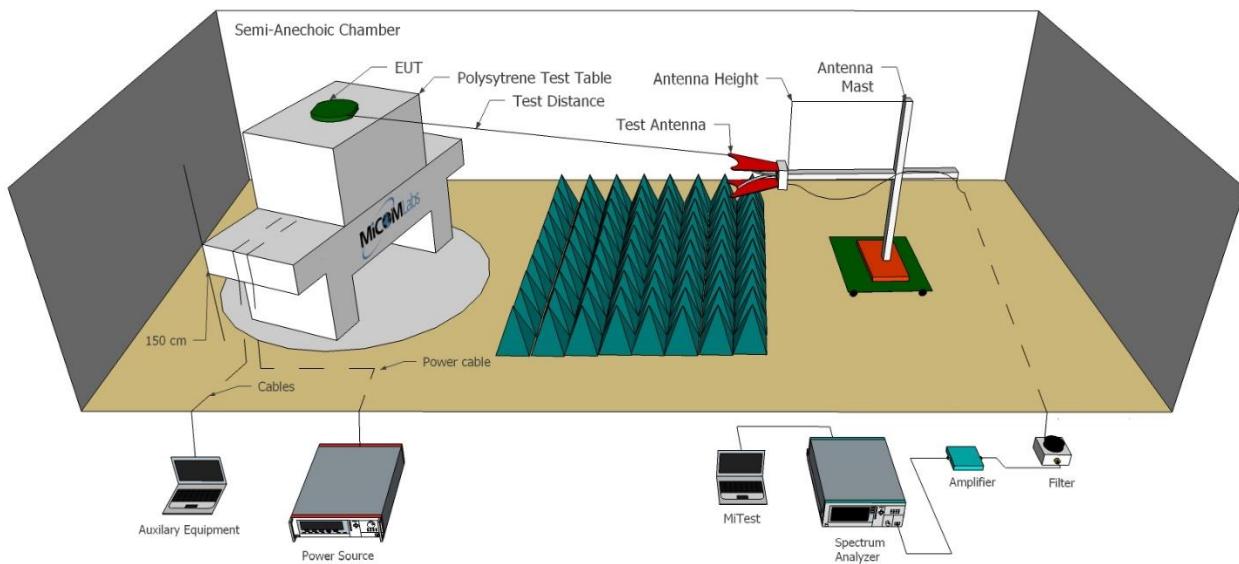
7.1. Radiated Emissions - 3m Chamber

The following tests were performed using the radiated test set-up shown in the diagrams below; - Radiated emissions below 1GHz; and Radiated Emissions above 1GHz.

Radiated Emissions Below 1GHz Test Setup



Radiated Emissions Above 1GHz Test Setup



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A full system calibration was performed on the test station and any resulting system losses (or gains) were taken into account in the production of all final measurement data.

Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
170	Video System Controller for Semi Anechoic Chamber	Panasonic	WV-CU101	04R08507	Not Required
298	3M Radiated Emissions Chamber Maintenance Check	MiCOM	3M Chamber	298	21 Jan 2019
338	Sunol 30 to 3000 MHz Antenna	Sunol	JB3	A052907	4 Apr 2019
341	900MHz Notch Filter	EWT	EWT-14-0199	H1	8 Oct 2019
342	2.4 GHz Notch Filter	EWT	EWT-14-0203	H1	8 Oct 2019
346	1.6 TO 10GHz High Pass Filter	EWT	EWT-57-0112	H1	8 Oct 2019
373	26III RMS Multimeter	Fluke	Fluke 26 series III	76080720	21 Sep 2019
378	Rohde & Schwarz 40 GHz Receiver with Generator	Rhode & Schwarz	ESIB40	100107/040	12 Oct 2019
393	DC - 1050 MHz Low Pass Filter	Microcircuits	VLFX-1050	N/A	8 Oct 2019
396	2.4 GHz Notch Filter	Microtronics	BRM50701	001	8 Oct 2019
397	Amp 10 - 2500MHz	MiCOM Labs	Amp 10 - 2500 MHz	NA	12 Jan 2019
399	ETS 1-18 GHz Horn Antenna	ETS	3117	00154575	12 Oct 2019
406	Amplifier for Radiated Emissions	MiCOM Labs	40dB 1 to 18GHz Amp	0406	12 Jan 2019
410	Desktop Computer	Dell	Inspiron 620	WS38	Not Required
411	Mast/Turntable Controller	Sunol Sciences	SC98V	060199-1D	Not Required
412	USB to GPIB Interface	National Instruments	GPIB-USB HS	11B8DC2	Not Required
413	Mast Controller	Sunol Science	TWR95-4	030801-3	Not Required
414	DC Power Supply 0-60V	HP	6274	1029A01285	Cal when used
415	Turntable Controller	Sunol Sciences	Turntable Controller	None	Not Required
447	MiTest Rad Emissions Test Software	MiCOM	Rad Emissions Test Software Version 1.0	447	Not Required
462	Schwarzbeck cable from Antenna to Amplifier.	Schwarzbeck	AK 9513	462	9 Oct 2019
463	Schwarzbeck cable from Amplifier to Bulkhead.	Schwarzbeck	AK 9513	463	9 Oct 2019
464	Schwarzbeck cable from Bulkhead to Receiver	Schwarzbeck	AK 9513	464	9 Oct 2019
465	Low Pass Filter DC-1000 MHz	Mini-Circuits	NLP-1200+	VUU01901402	9 Oct 2019

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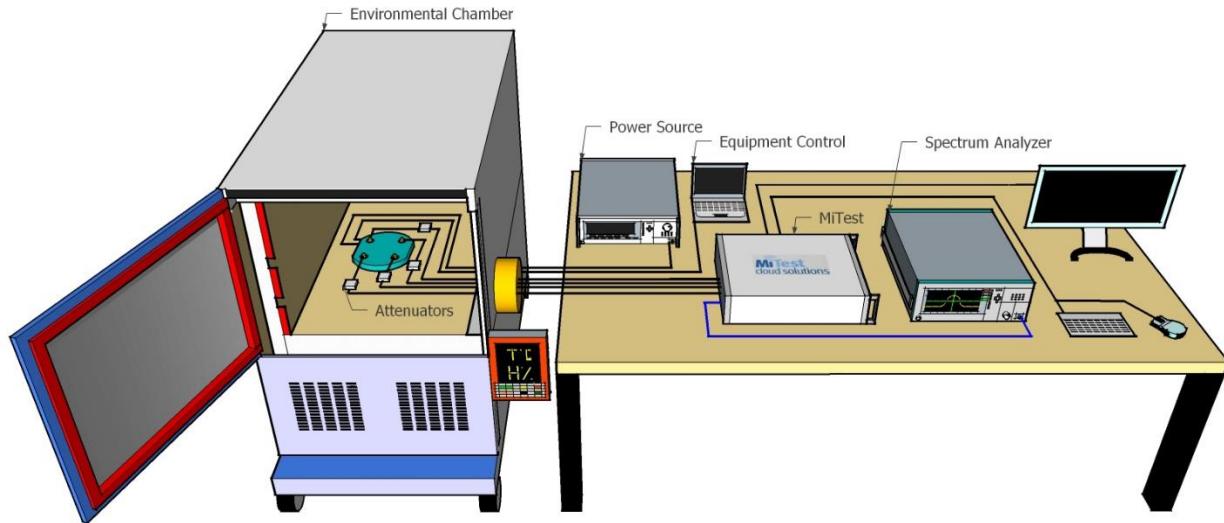
466	Low Pass Filter DC-1500 MHz	Mini-Circuits	NLP-1750+	VUU10401438	9 Oct 2019
467	2495 to 2650 MHz notch filter	MicroTronics	BRM50709	011	8 Oct 2019
480	Cable - Bulkhead to Amp	SRC Haverhill	157-3050360	480	24 Aug 2019
481	Cable - Bulkhead to Receiver	SRC Haverhill	151-3050787	481	24 Aug 2019
510	Barometer/Thermometer	Control Company	68000-49	170871375	11 Dec 2019
518	Cable - Amp to Antenna	SRC Haverhill	157-3051574	518	24 Aug 2019

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7.2. Conducted

Conducted RF Emission Test Set-up(s) The following tests were performed using the conducted test set-up shown in the diagram below.

MiTest Automated Test System



A full system calibration was performed on the test station and any resulting system losses (or gains) were taken into account in the production of all final measurement data.

Asset#	Description	Manufacturer	Model#	Serial#	Calibration Due Date
#3 SA	MiTest Box to SA	Fairview Microwave	SCA1814-0101-72	#3 SA	20 Jan 2019
#3P1	EUT to MiTest box port 1	Fairview Microwave	SCA1814-0101-72	#3P1	20 Jan 2019
#3P2	EUT to MiTest box port 2	Fairview Microwave	SCA1814-0101-72	#3P2	20 Jan 2019
#3P3	EUT to MiTest box port 3	Fairview Microwave	SCA1814-0101-72	#3P3	20 Jan 2019
#3P4	EUT to MiTest box port 4	Fairview Microwave	SCA1812-0101-72	#3P4	20 Jan 2019
249	Resistance Thermometer	Thermotronics	GR2105-02	9340 #2	30 Oct 2019
361	Desktop for RF#1, Labview Software installed	Dell	Vostro 220	WS RF#1	Not Required
378	Rohde & Schwarz 40 GHz Receiver with Generator	Rhode & Schwarz	ESIB40	100107/040	12 Oct 2019

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398	MiTest RF Conducted Test Software	MiCOM	MiTest ATS	Version 4.1	Not Required
405	DC Power Supply 0-60V	Agilent	6654A	MY4001826	Cal when used
408	USB to GPIB interface	National Instruments	GPIB-USB HS	14C0DE9	Not Required
436	USB Wideband Power Sensor	Boonton	55006	8731	14 Sep 2019
440	USB Wideband Power Sensor	Boonton	55006	9178	22 Sep 2019
441	USB Wideband Power Sensor	Boonton	55006	9179	20 Sep 2019
442	USB Wideband Power Sensor	Boonton	55006	9181	6 Oct 2019
445	PoE Injector	D-Link	DPE-101GL	QTAH1E2000625	Not Required
461	Spectrum Analyzer	Agilent	E4440A	MY46185537	20 Sep 2019
510	Barometer/Thermometer	Control Company	68000-49	170871375	11 Dec 2019
515	MiTest Cloud Solutions RF Test Box	MiCOM	2nd Gen with DFS	515	20 Jan 2019
75	Environmental Chamber	ThermaTron	SE-300-2-2	27946	24 Feb 2019

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8. MEASUREMENT AND PRESENTATION OF TEST DATA

The measurement and graphical data presented in this test report was generated automatically using state-of-the-art technology creating an easy to read report structure. Numerical measurement data is separated from supporting graphical data (plots) through hyperlinks. Numerical measurement data can be reviewed without scrolling through numerous graphical pages to arrive at the next data matrix.

Plots have been relegated into the Appendix 'Graphical Data'.

Test and report automation was performed by [MiTest](#). [MiTest](#) is an automated test system developed by MiCOM Labs. [MiTest](#) is the first cloud based modular test system enabling end-to-end automation of regulatory compliance testing for conducted RF testing.



The MiCOM Labs "[MiTest](#)" Automated Test System" (Patent Pending)

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9. TEST RESULTS

9.1. 20 dB & 99% Bandwidth

Conducted Test Conditions for 20 dB and 99% Bandwidth			
Standard:	FCC CFR 47:15.247 ISED RSS-247	Ambient Temp. (°C):	24.0 - 27.5
Test Heading:	20 dB and 99 % Bandwidth	Rel. Humidity (%):	32 - 45
Standard Section(s):	15.247 (a)(1)(i)/(ii) RSS-247 5.1 (d)	Pressure (mBars):	999 - 1001
Reference Document(s):	See Normative References		

Test Procedure for 20 dB and 99% Bandwidth Measurement

The bandwidth at 20 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.

Testing was performed under ambient conditions at nominal voltage. Where the device operated with multiple antenna ports i.e. MIMO device, each port was measured and reported.

Test configuration and setup used for the measurement was per the Conducted Test Set-up specified in this document.

Limits for 20 dB and 99% Bandwidth

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

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

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

(ii) Frequency hopping systems operating in the 5725-5850 MHz band shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

Equipment Configuration for 20 dB 99% Bandwidth	
--	--

Variant:	FHSS	Duty Cycle (%):	99
Data Rate:	2000.00 KBit/s	Antenna Gain (dBi):	Not Applicable
Modulation:	OQPSK	Beam Forming Gain (Y)(dB):	Not Applicable
TPC:	Not Applicable	Tested By:	SB
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Measured 20 dB Bandwidth (MHz)				20 dB Bandwidth (MHz)		Limit	Lowest Margin
	Port(s)							
MHz	a	b	c	d	Highest	Lowest	MHz	MHz
2401.0	0.108				0.108	0.108		--
2440.2	0.110				0.110	0.110		--
2479.4	0.109				0.109	0.109		--

Test Frequency	Measured 99% Bandwidth (MHz)				Maximum 99% Bandwidth (MHz)		
	Port(s)						
MHz	a	b	c	d			
2401.0	0.104				0.104		
2440.2	0.104				0.104		
2479.4	0.106				0.106		

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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9.2. Frequency Hopping Tests

Conducted Test Conditions for Frequency Hopping Measurements			
Standard:	FCC CFR 47:15.247 ISED RSS-247	Ambient Temp. (°C):	24.0 - 27.5
Test Heading:	Frequency Hopping Tests	Rel. Humidity (%):	32 - 45
Standard Section(s):	15.247 (a)(1)(i)/(ii) RSS-247 5.1 (b)(d)	Pressure (mBars):	999 - 1001
Reference Document(s):	See Normative References, FCC Public Notice DA 00-705		

Test Procedure for Frequency Hopping Measurements

These tests cover the following measurements:

- i) channel separation
- ii) channel occupancy
- iii) dwell time
- iv) number of hopping frequencies

Frequency hopping testing was measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate center frequency or hopping mode.

Testing was performed under ambient conditions at nominal voltage. Where the device operated with multiple antenna ports i.e. MIMO device, each port was measured and reported.

Test configuration and setup used for the measurement was per the Conducted Test Set-up specified in this document.

Limits for Frequency Hopping Measurements

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

- (1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.
- (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.
- (ii) Frequency hopping systems operating in the 5725-5850 MHz band shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.
- (iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

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9.2.1. Number of Hopping Channels

Equipment Configuration for Number of Hopping Channels

Variant:	FHSS	Antenna:	Not Applicable
Data Rate:	2000.00 KBit/s	Antenna Gain (dBi):	Not Applicable
Modulation:	OQPSK	Beam Forming Gain (Y)(dB):	Not Applicable
Duty Cycle (%):	99.0	Tested By:	SB
Engineering Test Notes:			

Test Measurement Results

Frequency Range (MHz)	Number of Hopping Channels	Limit	Pass / Fail
2400.0-2484.0	99	--	--
Total number of Hops	99	15	Pass

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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9.2.2. Channel Separation

Equipment Configuration for Channel Separation

Variant:	FHSS	Antenna:	Not Applicable
Data Rate:	2000.00 KBit/s	Antenna Gain (dBi):	Not Applicable
Modulation:	OQPSK	Beam Forming Gain (Y)(dB):	Not Applicable
Duty Cycle (%):	99.0	Tested By:	SB
Engineering Test Notes:			

Test Measurement Results

Center Frequency (MHz)	Chan Separation (MHz)	Limit (MHz)	Pass / Fail
2440.2	0.827	0.110	Pass

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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9.2.3. Dwell Time and Occupancy

Equipment Configuration for Channel Dwell & Occupancy Time

Variant:	FHSS	Antenna:	Not Applicable
Data Rate:	2000.00 KBit/s	Antenna Gain (dBi):	Not Applicable
Modulation:	OQPSK	Beam Forming Gain (Y)(dB):	Not Applicable
Duty Cycle (%):	99.0	Tested By:	SB
Engineering Test Notes:			

Test Measurement Results

Channel Frequency(MHz)	Dwell Time (Single Burst) (S)	Channel Occupancy (mS)	Observation Period (S)	Channel Occupancy Limit (mS)	Pass / Fail
2440.20	0.056	112.220	20.0	400.000	Pass

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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9.3. Output Power

Conducted Test Conditions for Fundamental Emission Output Power			
Standard:	FCC CFR 47:15.247 ISED RSS-247	Ambient Temp. (°C):	24.0 - 27.5
Test Heading:	Output Power	Rel. Humidity (%):	32 - 45
Standard Section(s):	15.247 (a)(1), (b)(1)/(2)/(3) RSS-247 5.4 (b)	Pressure (mBars):	999 - 1001
Reference Document(s):	See Normative References		

Test Procedure for Fundamental Emission Output Power Measurement

In the case of average power measurements an average power sensor was utilized.

For peak power measurements the spectrum analyzer built-in power function was used to integrate peak power over the 20 dB bandwidth.

Testing was performed under ambient conditions, nominal voltage. Where the device operated with multiple antenna ports i.e. MIMO device, each port was measured, summed (Σ) and reported.

Test configuration and setup used for the measurement was per the Conducted Test Set-up specified in this document.
Supporting Information

Calculated Power = $A + G + Y + 10 \log (1/x)$ dBm

A = Total Power $[10^{\text{a}/10} + 10^{\text{b}/10} + 10^{\text{c}/10} + 10^{\text{d}/10}]$

G = Antenna Gain

Y = Beamforming Gain

x = Duty Cycle (average power measurements only)

Limits for Fundamental Emission Output Power

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

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

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following for frequency hopping systems:

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

(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an

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alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

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Equipment Configuration for Output Power Peak

Variant:	FHSS	Duty Cycle (%):	99.0
Data Rate:	2000.00 KBit/s	Antenna Gain (dBi):	4.00
Modulation:	OQPSK	Beam Forming Gain (Y)(dB):	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	dB	
2401.0	19.01				19.01	30.00	-10.99	13.00
2440.2	20.56				20.56	30.00	-9.44	13.00
2479.4	20.19				20.19	30.00	-9.81	13.00

Traceability to Industry Recognized Test Methodologies

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

The above measurements are true pulse readings and therefore a Duty Cycling correction factor is not required.

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9.4. Emissions

9.4.1. Conducted Emissions

Conducted Test Conditions for Transmitter Conducted Spurious and Band-Edge Emissions			
Standard:	FCC CFR 47:15.247 ISED RSS-247	Ambient Temp. (°C):	24.0 - 27.5
Test Heading:	Transmitter Conducted Spurious and Band-Edge Emissions	Rel. Humidity (%):	32 - 45
Standard Section(s):	15.247 (d) RSS-247 5.5	Pressure (mBars):	999 - 1001
Reference Document(s):	See Normative References		

Test Procedure for Transmitter Conducted Spurious and Band-Edge Emissions Measurement

Transmitter Conducted Spurious and Band-Edge emissions were measured at a limit of 30 dBc (average detector) or 20 dBc (peak detector) below the highest in-band spectral density measured with a spectrum analyzer connected to the antenna terminal. 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.

Where the device operated with multiple antenna ports i.e. MIMO device, each port was measured separately. Testing was performed under ambient conditions at nominal voltage only.

Test configuration and setup used for the measurement was per the Conducted Test Set-up specified in this document.

Limits Transmitter Conducted Spurious and Band-Edge Emissions

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

9.4.1.1. Conducted Unwanted Spurious Emissions

Equipment Configuration for Unwanted Emissions Peak

Variant:	FHSS	Duty Cycle (%):	99
Data Rate:	2000.00 KBit/s	Antenna Gain (dBi):	Not Applicable
Modulation:	OQPSK	Beam Forming Gain (Y):	Not Applicable
TPC:	Not Applicable	Tested By:	SB
Engineering Test Notes:			

Test Measurement Results

Test Frequency	Frequency Range	Unwanted Emissions Peak (dBm)							
		Port a		Port b		Port c		Port d	
MHz	MHz	SE	Limit	SE	Limit	SE	Limit	SE	Limit
2401.0	30.0 - 10000.0	-42.722	2.236						
2440.2	30.0 - 10000.0	-42.232	1.880						
2479.4	30.0 - 10000.0	-41.861	1.640						

Traceability to Industry Recognized Test Methodologies

Work Instruction:	WI-05 MEASUREMENT OF SPURIOUS EMISSIONS
Measurement Uncertainty:	<=40 GHz ±2.37 dB, > 40 GHz ±4.6 dB

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

9.4.1.2. Conducted Band-Edge Emissions

Equipment Configuration for Conducted Low Band-Edge Emissions (Static) Peak

Variant:	FHSS	Duty Cycle (%):	99.0
Data Rate:	2000.00 KBit/s	Antenna Gain (dBi):	Not Applicable
Modulation:	OQPSK	Beam Forming Gain (Y)(dB):	Not Applicable
TPC:	Not Applicable	Tested By:	SB
Engineering Test Notes:			

Test Measurement Results

Channel Frequency:	2401.0 MHz				
Band-Edge Frequency:	2400.0 MHz				
Test Frequency Range:	22350.0 - 2405.0 MHz				
Port(s)	Band-Edge Markers and Limit			Revised Limit	Margin
	M1 Amplitude (dBm)	Plot Limit (dBm)	M2 Frequency (MHz)	Amplitude (dBm)	M2A Frequency (MHz)
a	-35.05	-2.57	2400.80		-0.800

Traceability to Industry Recognized Test Methodologies

Work Instruction:	WI-05 MEASUREMENT OF SPURIOUS EMISSIONS
Measurement Uncertainty:	"<=40 GHz ±2.37 dB, > 40 GHz ±4.6 dB"

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



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Equipment Configuration for Conducted Upper Band-Edge Emissions (Static) Peak

Variant:	FHSS	Duty Cycle (%):	99.0
Data Rate:	2000.00 KBit/s	Antenna Gain (dBi):	Not Applicable
Modulation:	OQPSK	Beam Forming Gain (Y)(dB):	Not Applicable
TPC:	Not Applicable	Tested By:	SB
Engineering Test Notes:			

Test Measurement Results

Channel Frequency:	2479.4 MHz				
Band-Edge Frequency:	2483.5 MHz				
Test Frequency Range:	2478.0 - 2533.0 MHz				
Port(s)	Band-Edge Markers and Limit			Revised Limit	Margin
	M3 Amplitude (dBm)	Plot Limit (dBm)	M2 Frequency (MHz)	Amplitude (dBm)	M2A Frequency (MHz)
a	-40.63	-1.40	2479.70		-3.800

Traceability to Industry Recognized Test Methodologies

Work Instruction:	WI-05 MEASUREMENT OF SPURIOUS EMISSIONS		
Measurement Uncertainty:	<=40 GHz ±2.37 dB, > 40 GHz ±4.6 dB		

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

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Equipment Configuration for Conducted Low Band-Edge Emissions (Hopping) Peak

Variant:	FHSS	Duty Cycle (%):	99.0
Data Rate:	2000.00 KBit/s	Antenna Gain (dBi):	Not Applicable
Modulation:	OQPSK	Beam Forming Gain (Y)(dB):	Not Applicable
TPC:	Not Applicable	Tested By:	SB
Engineering Test Notes:			

Test Measurement Results

Channel Frequency:	2401.0 MHz				
Band-Edge Frequency:	2400.0 MHz				
Test Frequency Range:	2350.0 - 2405.0 MHz				
Port(s)	Band-Edge Markers and Limit			Revised Limit	Margin
	M1 Amplitude (dBm)	Plot Limit (dBm)	M2 Frequency (MHz)	Amplitude (dBm)	M2A Frequency (MHz)
a	-40.96	-1.72	2400.80		-0.800

Traceability to Industry Recognized Test Methodologies

Work Instruction:	WI-05 MEASUREMENT OF SPURIOUS EMISSIONS
Measurement Uncertainty:	<=40 GHz ±2.37 dB, > 40 GHz ±4.6 dB

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

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Equipment Configuration for Conducted Upper Band-Edge Emissions (Hopping) Peak

Variant:	FHSS	Duty Cycle (%):	99.0
Data Rate:	2000.00 KBit/s	Antenna Gain (dBi):	Not Applicable
Modulation:	OQPSK	Beam Forming Gain (Y)(dB):	Not Applicable
TPC:	Not Applicable	Tested By:	SB
Engineering Test Notes:			

Test Measurement Results

Channel Frequency:	2479.4 MHz				
Band-Edge Frequency:	2483.5 MHz				
Test Frequency Range:	2478.0 - 2534.0 MHz				
Port(s)	Band-Edge Markers and Limit			Revised Limit	Margin
	M3 Amplitude (dBm)	Plot Limit (dBm)	M2 Frequency (MHz)	Amplitude (dBm)	M2A Frequency (MHz)
a	-41.17	-1.20	2479.70		-3.800

Traceability to Industry Recognized Test Methodologies

Work Instruction:	WI-05 MEASUREMENT OF SPURIOUS EMISSIONS
Measurement Uncertainty:	<=40 GHz ±2.37 dB, > 40 GHz ±4.6 dB

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

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9.4.2. Radiated Emissions

Radiated Test Conditions for Radiated Spurious and Band-Edge Emissions (Restricted Bands)			
Standard:	FCC CFR 47:15.247 ISED RSS-247 ISED RSS-Gen	Ambient Temp. (°C):	20.0 - 24.5
Test Heading:	Radiated Spurious and Band-Edge Emissions	Rel. Humidity (%):	32 - 45
Standard Section(s):	15.205, 15.209 RSS-247 5.5 RSS Gen 6.13	Pressure (mBars):	999 - 1001
Reference Document(s):	See Normative References		

Test Procedure for Radiated Spurious and Band-Edge Emissions (Restricted Bands)

Radiated emissions for restricted bands 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. Measurements on any restricted band frequency or frequencies above 1 GHz are based on the use of measurement instrumentation employing peak and average detectors. All measurements were performed using a resolution bandwidth of 1 MHz.

Test configuration and setup for Radiated Spurious and Band-Edge Measurement were per the Radiated Test Set-up specified in this document.

Limits for Restricted Bands

Peak emission: 74 dBuV/m

Average emission: 54 dBuV/m

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

Example:

Given receiver input reading of 51.5 dBmV; 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 (FS) of the measured emission is:

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

Conversion between dBmV/m (or dBmV) and mV/m (or mV) are as follows:

$$\text{Level (dBmV/m)} = 20 * \log (\text{level (mV/m)})$$

$$40 \text{ dBmV/m} = 100 \text{ mV/m}$$

$$48 \text{ dBmV/m} = 250 \text{ mV/m}$$

Restricted Bands of Operation (15.205)

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

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below:

Frequency Band			
MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

(b) Except as provided 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 §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

(c) Except as provided in paragraphs (d) and (e) of this section, regardless of the field strength limits specified elsewhere in this subpart, the provisions of this section apply to emissions from any intentional radiator.

(d) The following devices are exempt from the requirements of this section:

(1) Swept frequency field disturbance sensors operating between 1.705 and 37 MHz provided their emissions only sweep through the bands listed in paragraph (a) of this section, the sweep is never stopped with the fundamental emission within the bands listed in paragraph (a) of this section, and the fundamental emission is outside of the bands listed in paragraph (a) of this section more than 99% of the time the device is actively transmitting, without compensation for duty cycle.

(2) Transmitters used to detect buried electronic markers at 101.4 kHz which are employed by telephone companies.

(3) Cable locating equipment operated pursuant to §15.213.

(4) Any equipment operated under the provisions of §15.253, 15.255, and 15.256 in the frequency band 75-85 GHz, or §15.257 of this part.

(5) Biomedical telemetry devices operating under the provisions of §15.242 of this part are not subject to the restricted band 608-614 MHz but are subject to compliance within the other restricted bands.

(6) Transmitters operating under the provisions of subparts D or F of this part.

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(7) Devices operated pursuant to §15.225 are exempt from complying with this section for the 13.36-13.41 MHz band only.

(8) Devices operated in the 24.075-24.175 GHz band under §15.245 are exempt from complying with the requirements of this section for the 48.15-48.35 GHz and 72.225-72.525 GHz bands only, and shall not exceed the limits specified in §15.245(b).

(9) Devices operated in the 24.0-24.25 GHz band under §15.249 are exempt from complying with the requirements of this section for the 48.0-48.5 GHz and 72.0-72.75 GHz bands only, and shall not exceed the limits specified in §15.249(a).

(e) Harmonic emissions appearing in the restricted bands above 17.7 GHz from field disturbance sensors operating under the provisions of §15.245 shall not exceed the limits specified in §15.245(b).



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9.4.2.3. TX Spurious & Restricted Band Emissions

Equipment Configuration for TX Spurious & Restricted Band Emissions

Antenna:	Shoof Tech. FHSS Antenna	Variant:	FHSS
Antenna Gain (dBi):	0.00	Modulation:	OQPSK
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	99
Channel Frequency (MHz):	2401.00	Data Rate:	2000.00 KBit/s
Power Setting:	13	Tested By:	JMH

Test Measurement Results

1000.00 - 18000.00 MHz														
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail		
#1	2400.17	56.21	-1.76	-12.42	42.03	Fundamental	Vertical	100	0	--	--			
#2	4800.42	64.84	-2.56	-12.46	49.82	Max Peak	Horizontal	122	236	74.0	-24.2	Pass		
#3	4800.42	60.09	-2.56	-12.46	45.07	Max Avg	Horizontal	122	236	54.0	-8.9	Pass		
#4	7200.56	56.87	-3.00	-7.37	46.50	Peak (NRB)	Vertical	100	0	--	--	Pass		
#5	9600.80	58.48	-3.90	-6.82	47.76	Peak (NRB)	Horizontal	100	0	--	--	Pass		
#6	12000.93	68.59	-4.12	-7.10	57.37	Max Peak	Horizontal	196	328	74.0	-16.6	Pass		
#7	12000.93	65.10	-4.12	-7.10	53.88	Max Avg	Horizontal	196	328	54.0	-0.1	Pass		

Test Notes: EUT powered by DC Linear PS. 2.4 G notch in front of amp to prevent overload.

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

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Equipment Configuration for TX Spurious & Restricted Band Emissions

Antenna:	Shoof Tech. FHSS Antenna	Variant:	FHSS
Antenna Gain (dBi):	0.00	Modulation:	OQPSK
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	99
Channel Frequency (MHz):	2440.20	Data Rate:	2000.00 KBit/s
Power Setting:	13	Tested By:	JMH

Test Measurement Results

1000.00 - 18000.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
#1	2440.20	65.88	-1.79	-12.08	52.01	Fundamental	Vertical	100	0	--	--		
#2	4880.39	65.31	-2.50	-12.50	50.31	Max Peak	Horizontal	130	250	74.0	-23.7	Pass	
#3	4880.39	61.23	-2.50	-12.50	46.23	Max Avg	Horizontal	130	250	54.0	-7.8	Pass	
#4	7320.55	66.53	-3.00	-7.86	55.67	Max Peak	Vertical	130	76	74.0	-18.3	Pass	
#5	7320.55	63.45	-3.00	-7.86	52.59	Max Avg	Vertical	130	76	54.0	-1.4	Pass	
#6	9760.79	62.94	-3.69	-5.93	53.32	Peak (NRB)	Horizontal	100	0	--	--	Pass	
#7	12201.03	62.32	-4.30	-4.77	53.25	Max Peak	Horizontal	136	161	74.0	-20.8	Pass	
#8	12201.03	55.47	-4.30	-4.77	46.40	Max Avg	Horizontal	136	161	54.0	-7.6	Pass	

Test Notes: Powered by DC Linear PS. 2.4G notch in front of amp to prevent overload.

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

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Equipment Configuration for TX Spurious & Restricted Band Emissions

Antenna:	Shoof Tech. FHSS Antenna	Variant:	FHSS
Antenna Gain (dBi):	0.00	Modulation:	OQPSK
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	99
Channel Frequency (MHz):	2479.40	Data Rate:	2000.00 KBit/s
Power Setting:	15	Tested By:	JMH

Test Measurement Results

1000.00 - 18000.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
#1	2479.39	63.72	-1.77	-12.60	49.35	Fundamental	Vertical	100	0	--	--		
#2	4958.69	66.86	-2.55	-12.10	52.21	Max Peak	Horizontal	105	298	74.0	-21.8	Pass	
#3	4958.69	63.38	-2.55	-12.10	48.73	Max Avg	Horizontal	105	298	54.0	-5.3	Pass	
#4	7438.22	67.48	-3.00	-8.04	56.44	Max Peak	Vertical	142	85	74.0	-17.6	Pass	
#5	7438.22	64.53	-3.00	-8.04	53.49	Max Avg	Vertical	142	85	54.0	-0.5	Pass	
#6	9917.40	69.27	-3.73	-6.97	58.57	Peak (NRB)	Horizontal	100	0	--	--	Pass	
#7	12396.93	67.15	-4.12	-5.79	57.24	Max Peak	Horizontal	196	160	74.0	-16.8	Pass	
#8	12396.93	62.50	-4.12	-5.79	52.59	Max Avg	Horizontal	196	160	54.0	-1.4	Pass	

Test Notes: Powered by DC Linear PS. 2.4G notch in front of amp to prevent overload.

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

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Equipment Configuration for TX Spurious & Restricted Band Emissions

Antenna:	WP WPANT30211-S1A	Variant:	FHSS
Antenna Gain (dBi):	3.50	Modulation:	OQPSK
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	99
Channel Frequency (MHz):	2401.00	Data Rate:	2000.00 KBit/s
Power Setting:	13	Tested By:	JMH

Test Measurement Results

1000.00 - 18000.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
#1	2401.87	55.31	-1.76	-12.41	41.14	Fundamental	Vertical	100	0	--	--		
#2	4803.59	70.57	-2.55	-12.38	55.64	Max Peak	Vertical	119	68	74.0	-18.4	Pass	
#3	4803.59	68.50	-2.55	-12.38	53.57	Max Avg	Vertical	119	68	54.0	-0.4	Pass	
#4	7205.55	59.79	-3.01	-7.37	49.41	Peak (NRB)	Vertical	100	0	--	--	Pass	
#5	9607.49	57.59	-3.92	-6.64	47.03	Peak (NRB)	Horizontal	100	0	--	--	Pass	
#6	12009.18	64.88	-4.20	-7.08	53.60	Max Peak	Vertical	111	159	74.0	-20.4	Pass	
#7	12009.18	58.68	-4.20	-7.08	47.40	Max Avg	Vertical	111	159	54.0	-6.6	Pass	

Test Notes: EUT powered by DC Linear PS. 2.4G Notch in front of amp to prevent overload

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

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Equipment Configuration for TX Spurious & Restricted Band Emissions

Antenna:	WP WPANT30211-S1A	Variant:	FHSS
Antenna Gain (dBi):	3.50	Modulation:	OQPSK
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	99
Channel Frequency (MHz):	2440.20	Data Rate:	2000.00 KBit/s
Power Setting:	13	Tested By:	JMH

Test Measurement Results

1000.00 - 18000.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
#1	2440.19	63.80	-1.79	-12.08	49.93	Fundamental	Vertical	100	0	--	--		
#2	4880.43	66.34	-2.50	-12.50	51.34	Max Peak	Vertical	153	19	74.0	-22.7	Pass	
#3	4880.43	62.64	-2.50	-12.50	47.64	Max Avg	Vertical	153	19	54.0	-6.4	Pass	
#4	7320.76	66.28	-3.00	-7.86	55.42	Max Peak	Vertical	139	319	74.0	-18.6	Pass	
#5	7320.76	62.57	-3.00	-7.86	51.71	Max Avg	Vertical	139	319	54.0	-2.3	Pass	
#6	9760.92	55.88	-3.69	-5.93	46.26	Peak (NRB)	Vertical	151	129	--	--	Pass	
#7	12201.10	62.85	-4.30	-4.77	53.78	Max Peak	Horizontal	150	24	74.0	-20.2	Pass	
#8	12201.10	57.09	-4.30	-4.77	48.02	Max Avg	Horizontal	150	24	54.0	-6.0	Pass	

Test Notes: EUT powered by DC Linear PS. 2.4G Notch in front of amp to prevent overload

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

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Equipment Configuration for TX Spurious & Restricted Band Emissions

Antenna:	WP WPANT30211-S1A	Variant:	FHSS
Antenna Gain (dBi):	3.50	Modulation:	OQPSK
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	99
Channel Frequency (MHz):	2479.40	Data Rate:	2000.00 KBit/s
Power Setting:	13	Tested By:	JMH

Test Measurement Results

1000.00 - 18000.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
#1	2480.24	62.41	-1.77	-11.87	48.77	Fundamental	Vertical	151	0	--	--		
#2	4960.44	64.94	-2.55	-12.13	50.26	Max Peak	Vertical	160	14	74.0	-23.7	Pass	
#3	4960.44	60.87	-2.55	-12.13	46.19	Max Avg	Vertical	160	14	54.0	-7.8	Pass	
#4	7440.73	65.48	-3.00	-8.01	54.47	Max Peak	Vertical	141	109	74.0	-19.5	Pass	
#5	7440.73	61.84	-3.00	-8.01	50.83	Max Avg	Vertical	141	109	54.0	-3.2	Pass	
#6	9920.97	59.10	-3.73	-6.96	48.41	Peak (NRB)	Horizontal	151	0	--	--	Pass	
#7	12401.07	65.12	-4.15	-6.00	54.97	Max Peak	Vertical	125	16	74.0	-19.0	Pass	
#8	12401.07	59.44	-4.15	-6.00	49.29	Max Avg	Vertical	125	16	54.0	-4.7	Pass	

Test Notes: EUT powered by DC Linear PS. 2.4G Notch in front of amp to prevent overload

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

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9.4.2.4. Restricted Edge & Band-Edge Emissions

Shoof Integral Antenna:

Shoof FHSS Antenna		Band-Edge Freq	Limit 74.0dB μ V/m	Limit 54.0dB μ V/m	Power Setting
Operational Mode	Operating Frequency (MHz)	MHz	dB μ V/m	dB μ V/m	
OQPSK	2401.00	2390.00	60.35	47.91	13
OQPSK	2479.40	2483.50	65.67	53.68	15

Shoof FHSS Antenna		Band-Edge Freq	Limit 74.0dB μ V/m	Limit 54.0dB μ V/m	Power Setting
Operational Mode	Operating Frequency (MHz)	MHz	dB μ V/m	dB μ V/m	
OQPSK	Hopping	2390.00	71.36	40.09	13
OQPSK	Hopping	2483.50	68.66	49.16	13

Note: click the links in the above matrix



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Equipment Configuration for Radiated - Lower Restricted Band-Edge Emissions

Antenna:	Shoof Tech. FHSS Antenna	Variant:	FHSS
Antenna Gain (dBi):	0.00	Modulation:	OQPSK
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	99
Channel Frequency (MHz):	2401.00	Data Rate:	2000.00 KBit/s
Power Setting:	13	Tested By:	JMH

Test Measurement Results

2310.00 - 2422.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
#1	2386.99	17.74	-1.77	31.94	47.91	Max Avg	Vertical	116	221	54.0	-6.1	Pass	
#2	2390.00	30.19	-1.77	31.93	60.35	Max Peak	Vertical	116	221	74.0	-13.7	Pass	
#3	2390.00	--	--	--	--	Restricted-Band	--	--	--	--	--	--	

Test Notes: EUT powered by DC Linear PS.

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

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Equipment Configuration for Radiated - Upper Restricted Band-Edge Emissions

Antenna:	Shoof Tech. FHSS Antenna	Variant:	FHSS
Antenna Gain (dBi):	0.0	Modulation:	OQPSK
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	99
Channel Frequency (MHz):	2479.40	Data Rate:	2000.00 KBit/s
Power Setting:	15	Tested By:	JMH

Test Measurement Results

2475.00 - 2550.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
#1	2483.50	23.13	-1.78	32.33	53.68	Max Avg	Vertical	116	221	54.0	-0.3	Pass	
#2	2483.50	35.12	-1.78	32.33	65.67	Max Peak	Vertical	116	221	74.0	-8.3	Pass	
#3	2483.50	--	--	--	--	Restricted-Band	--	--	--	--	--	--	

Test Notes: EUT powered by DC Linear PS.

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

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Equipment Configuration for Radiated - Lower Restricted Band-Edge Emissions

Antenna:	Shoof Tech. FHSS Antenna	Variant:	FHSS
Antenna Gain (dBi):	0.0	Modulation:	OQPSK
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	99
Channel Frequency (MHz):	Hopping	Data Rate:	2000.00 KBit/s
Power Setting:	13	Tested By:	JMH

Test Measurement Results

2310.00 - 2422.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
#1	2384.52	41.20	-1.77	31.93	71.36	Max Peak	Vertical	116	221	74.0	-2.6	Pass	
#2	2387.98	9.91	-1.77	31.95	40.09	Max Avg	Vertical	116	221	54.0	-13.9	Pass	
#3	2390.00	--	--	--	--	Restricted-Band	--	--	--	--	--	--	

Test Notes: EUT powered by DC Linear PS. Hopping

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Equipment Configuration for Radiated - Upper Restricted Band-Edge Emissions

Antenna:	Shoof Tech. FHSS Antenna	Variant:	FHSS
Antenna Gain (dBi):	Not Applicable	Modulation:	OQPSK
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	99
Channel Frequency (MHz):	Hopping	Data Rate:	2000.00 KBit/s
Power Setting:	13	Tested By:	JMH

Test Measurement Results

2475.00 - 2550.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
#2	2484.17	18.61	-1.78	32.33	49.16	Max Avg	Vertical	116	221	54.0	-4.8	Pass	
#3	2489.58	38.12	-1.78	32.32	68.66	Max Peak	Vertical	116	221	74.0	-5.3	Pass	
#1	2483.50	--	--	--	--	Restricted-Band	--	--	--	--	--	--	

Test Notes: EUT powered by DC Linear PS. Hopping

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WP-WPANT30211-S1A External Antenna:

WP WPANT30211-S1A		Band-Edge Freq	Limit 74.0dB μ V/m	Limit 54.0dB μ V/m	Power Setting
Operational Mode	Operating Frequency (MHz)	MHz	dB μ V/m	dB μ V/m	
OQPSK	2401.00	2390.00	54.39	41.79	19
OQPSK	2479.40	2483.50	66.38	53.75	15

WP WPANT30211-S1A		Band-Edge Freq	Limit 74.0dB μ V/m	Limit 54.0dB μ V/m	Power Setting
Operational Mode	Operating Frequency (MHz)	MHz	dB μ V/m	dB μ V/m	
OQPSK	Hopping	2390.00	68.27	38.33	13
OQPSK	Hopping	2483.50	70.19	47.93	13

Note: click the links in the above matrix

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Equipment Configuration for Radiated - Lower Restricted Band-Edge Emissions

Antenna:	WP WPANT30211-S1A	Variant:	FHSS
Antenna Gain (dBi):	3.5	Modulation:	OQPSK
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	99
Channel Frequency (MHz):	2401.00	Data Rate:	2000.00 KBit/s
Power Setting:	19	Tested By:	JMH

Test Measurement Results

2310.00 - 2422.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
#1	2390.00	11.60	-1.77	31.96	41.79	Max Avg	Vertical	143	176	54.0	-12.2	Pass	
#2	2390.00	24.20	-1.77	31.96	54.39	Max Peak	Vertical	143	176	74.0	-19.6	Pass	
#3	2390.00	--	--	--	--	Restricted-Band	--	--	--	--	--	--	

Test Notes: EUT powered by DC Linear PS.

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

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Equipment Configuration for Radiated - Upper Restricted Band-Edge Emissions

Antenna:	WP WPANT30211-S1A	Variant:	FHSS
Antenna Gain (dBi):	3.5	Modulation:	OQPSK
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	99
Channel Frequency (MHz):	2479.40	Data Rate:	2000.00 KBit/s
Power Setting:	15	Tested By:	JMH

Test Measurement Results

2475.00 - 2550.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
#1	2483.50	23.20	-1.78	32.33	53.75	Max Avg	Vertical	143	176	54.0	-0.3	Pass	
#2	2483.50	35.83	-1.78	32.33	66.38	Max Peak	Vertical	143	176	74.0	-7.6	Pass	
#3	2483.50	--	--	--	--	Restricted-Band	--	--	--	--	--	--	

Test Notes: EUT powered by DC Linear PS

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

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Equipment Configuration for Radiated - Lower Restricted Band-Edge Emissions

Antenna:	WP WPANT30211-S1A	Variant:	FHSS
Antenna Gain (dBi):	3.50	Modulation:	OQPSK
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	99
Channel Frequency (MHz):	Hopping	Data Rate:	2000.00 KBit/s
Power Setting:	13	Tested By:	JMH

Test Measurement Results

2310.00 - 2422.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
#1	2372.62	36.40	0.00	31.87	68.27	Max Peak	Vertical	143	176	74.0	-5.7	Pass	
#2	2381.82	8.17	-1.76	31.92	38.33	Max Avg	Vertical	143	176	54.0	-15.7	Pass	
#3	2390.00	--	--	--	--	Restricted-Band	--	--	--	--	--	--	

Test Notes: EUT powered by DC Linear PS. Hopping

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

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Equipment Configuration for Radiated - Upper Restricted Band-Edge Emissions

Antenna:	WP WPANT30211-S1A	Variant:	FHSS
Antenna Gain (dBi):	3.50	Modulation:	OQPSK
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	99
Channel Frequency (MHz):	Hopping	Data Rate:	2000.00 KBit/s
Power Setting:	13	Tested By:	JMH

Test Measurement Results

2475.00 - 2550.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
#2	2484.77	17.38	-1.78	32.33	47.93	Max Avg	Vertical	143	176	54.0	-6.1	Pass	
#3	2498.29	39.64	-1.77	32.32	70.19	Max Peak	Vertical	143	176	74.0	-3.8	Pass	
#1	2483.50	--	--	--	--	Restricted-Band	--	--	--	--	--	--	

Test Notes: EUT powered by DC Linear PS. Hopping

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

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9.4.3. Digital Emissions

Radiated Test Conditions for Radiated Digital Emissions (0.03 – 1 GHz)			
Standard:	FCC CFR 47:15.247 ISED RSS-Gen	Ambient Temp. (°C):	20.0 - 24.5
Test Heading:	Digital Emissions	Rel. Humidity (%):	32 - 45
Standard Section(s):	15.209 RSS Gen 8.9	Pressure (mBars):	999 - 1001
Reference Document(s):	See Normative References		

Test Procedure for Radiated Digital Emissions (0.03 – 1 GHz)

Testing 30M-1 GHz was performed in a 3-meter anechoic chamber using a CISPR compliant receiver. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. To further maximize emissions the receive antenna was varied between 1 and 4 meters. The emissions are recorded with receiver in peak hold mode. Emissions closest to the limits are measured in the quasi-peak mode with the tuned receiver using a bandwidth of 120 kHz. Only the highest emissions relative to the limit are listed.

Test configuration and setup for Radiated Spurious and Band-Edge Measurement were per the Radiated Test Set-up specified in this document.

Field Strength Calculation

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

$$FS = R + AF + CORR$$

where:

FS = Field Strength

R = Measured Receiver Input Amplitude

AF = Antenna Factor

CORR = Correction Factor = CL – AG + NFL

CL = Cable Loss

AG = Amplifier Gain

For example:

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

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

Conversion between dBmV/m (or dBmV) and mV/m (or mV) are done as:

$$\text{Level (dBmV/m)} = 20 * \text{Log (level (mV/m))}$$

$$40 \text{ dBmV/m} = 100\text{mV/m}$$

$$48 \text{ dBmV/m} = 250\text{mV/m}$$

Limits for Radiated Digital Emissions (0.03 – 1 GHz)

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

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Frequency (MHz)	Field Strength		Measurement Distance (m)
	µV/m (microvolts/meter)	dBµV/m (dB microvolts/meter)	
0.009-0.490	2400/F(kHz)	--	300
0.490-1.705	24000/F(kHz)	--	30
1.705-30.0	30	29.5	30
30-88	100**	40	3
88-216	150**	43.5	3
216-960	200**	46.0	3
Above 960	500	54.0	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241. (b) In the emission table above, the tighter limit applies at the band edges. (c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency. (d) The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector. (e) The provisions in §§15.31, 15.33, and 15.35 for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part. (f) In accordance with §15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation of a digital device. If measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in §15.109 and as based on the frequency of the emission being measured, or, except for emissions contained in the restricted frequency bands shown in §15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit. Emissions which must be measured above the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator and which fall within the restricted bands shall comply with the general radiated emission limits in §15.109 that are applicable to the incorporated digital device. (g) Perimeter protection systems may operate in the 54-72 MHz and 76-88 MHz bands under the provisions of this section. The use of such perimeter protection systems is limited to industrial, business and commercial applications.



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Equipment Configuration for Radiated Digital Emissions

Antenna:	Shoof Tech. FHSS Antenna	Variant:	FHSS
Antenna Gain (dBi):	0.00	Modulation:	OQPSK
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	99
Channel Frequency (MHz):	2440.20	Data Rate:	2000.00 KBit/s
Power Setting:	Max	Tested By:	JMH

Test Measurement Results

30.00 - 1000.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
#1	438.91	40.39	5.31	-11.30	34.40	MaxQP	Vertical	111	195	46.0	-11.6	Pass	
#2	484.10	35.12	5.47	-10.00	30.59	MaxQP	Horizontal	101	156	46.0	-15.4	Pass	

Test Notes: EUT powered by DC Linear PS.

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

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Equipment Configuration for Radiated Digital Emissions

Antenna:	WP WPANT30211-S1A	Variant:	FHSS
Antenna Gain (dBi):	3.50	Modulation:	OQPSK
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	99
Channel Frequency (MHz):	2440.20	Data Rate:	2000.00 KBit/s
Power Setting:	Max	Tested By:	JMH

Test Measurement Results

[Click here to view measurement data...](#)

Test Notes: EUT powered by DC Linear PS. Digital

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

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Equipment Configuration for Restricted Band Spurious Emissions

Antenna:	Not Applicable	Variant:	FHSS
Antenna Gain (dBi):	Not Applicable	Modulation:	Not Applicable
Beam Forming Gain (Y):	Not Applicable	Duty Cycle (%):	Not Applicable
Channel Frequency (MHz):	0.00	Data Rate:	Not Applicable
Power Setting:	Not Applicable	Tested By:	JMH

Test Measurement Results

[Click here to view measurement data...](#)

Test Notes: EUT powered by DC linear PS, Receiver

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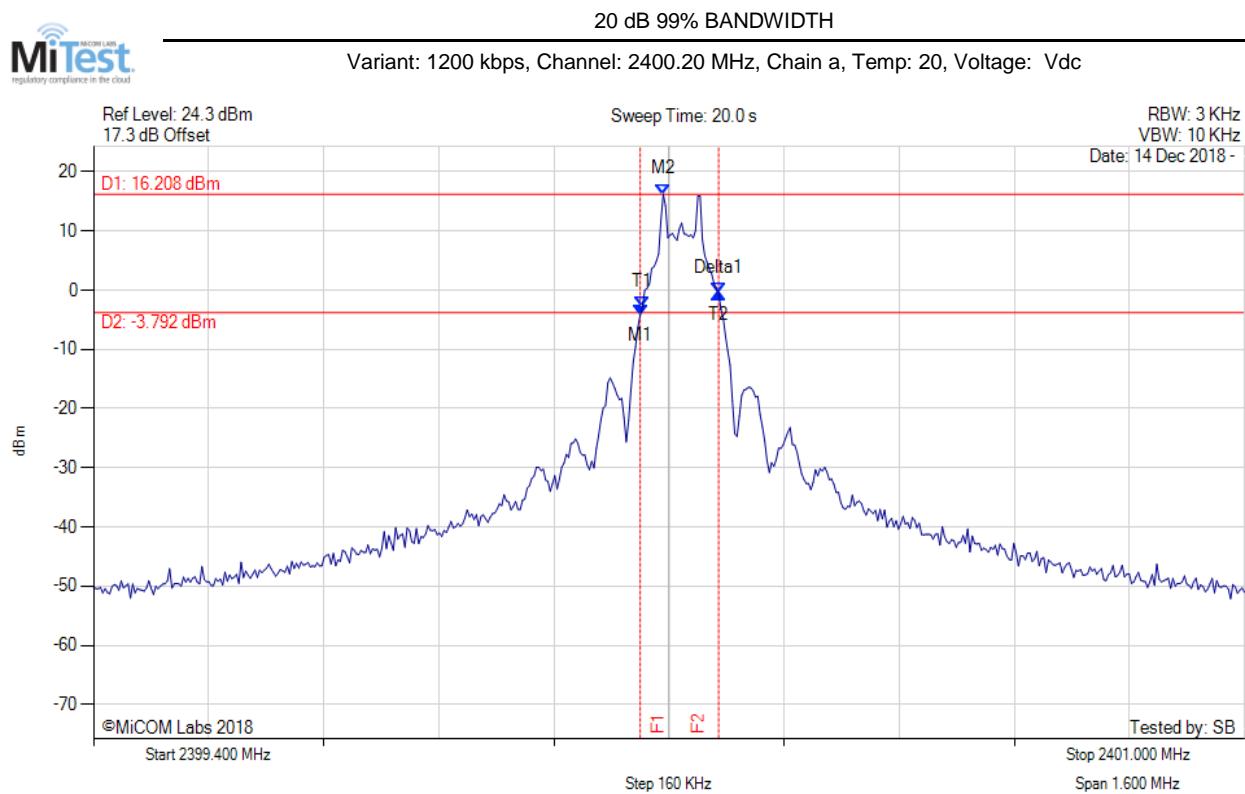


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A. APPENDIX - GRAPHICAL IMAGES

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A.1. 20 dB & 99% Bandwidth



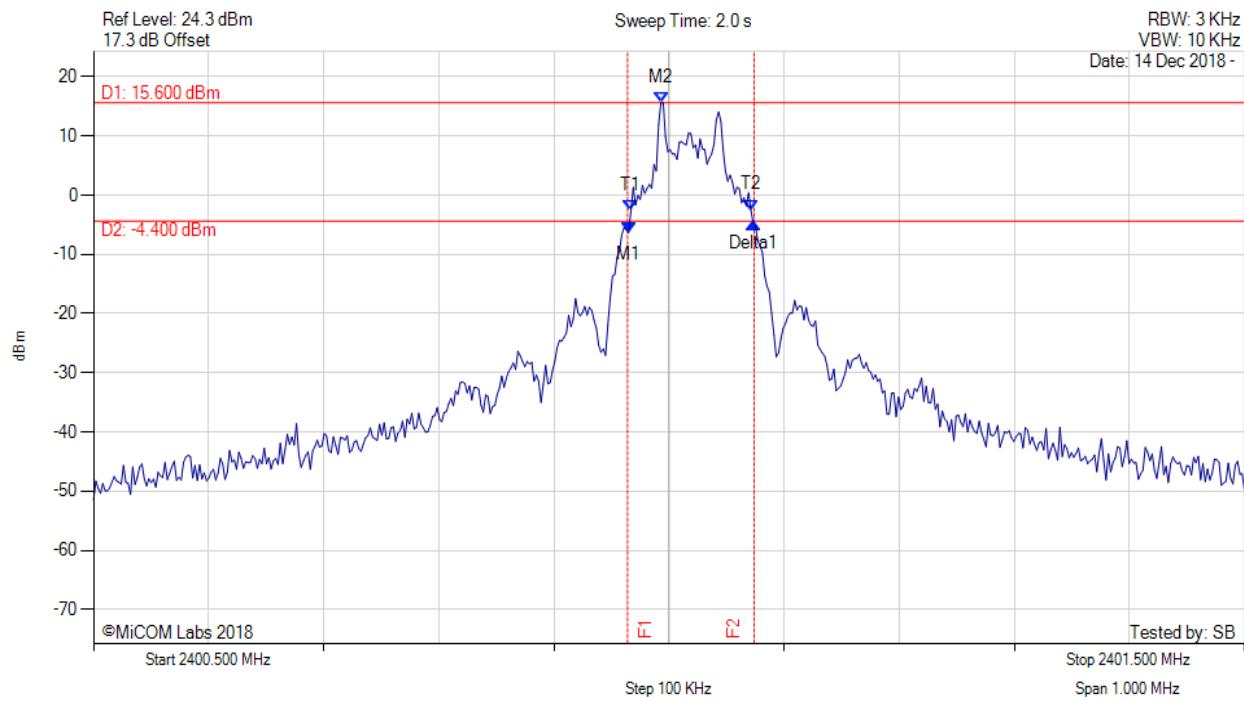
Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = MAX HOLD	M1 : 2400.160 MHz : -4.156 dBm M2 : 2400.192 MHz : 16.208 dBm Delta1 : 109 KHz : 3.675 dB T1 : 2400.163 MHz : -2.806 dBm T2 : 2400.269 MHz : -0.481 dBm OBW : 106 KHz	Measured 20 dB Bandwidth: 0.109 MHz Limit: KHz Margin: #VALUE! MHz

[back to matrix](#)

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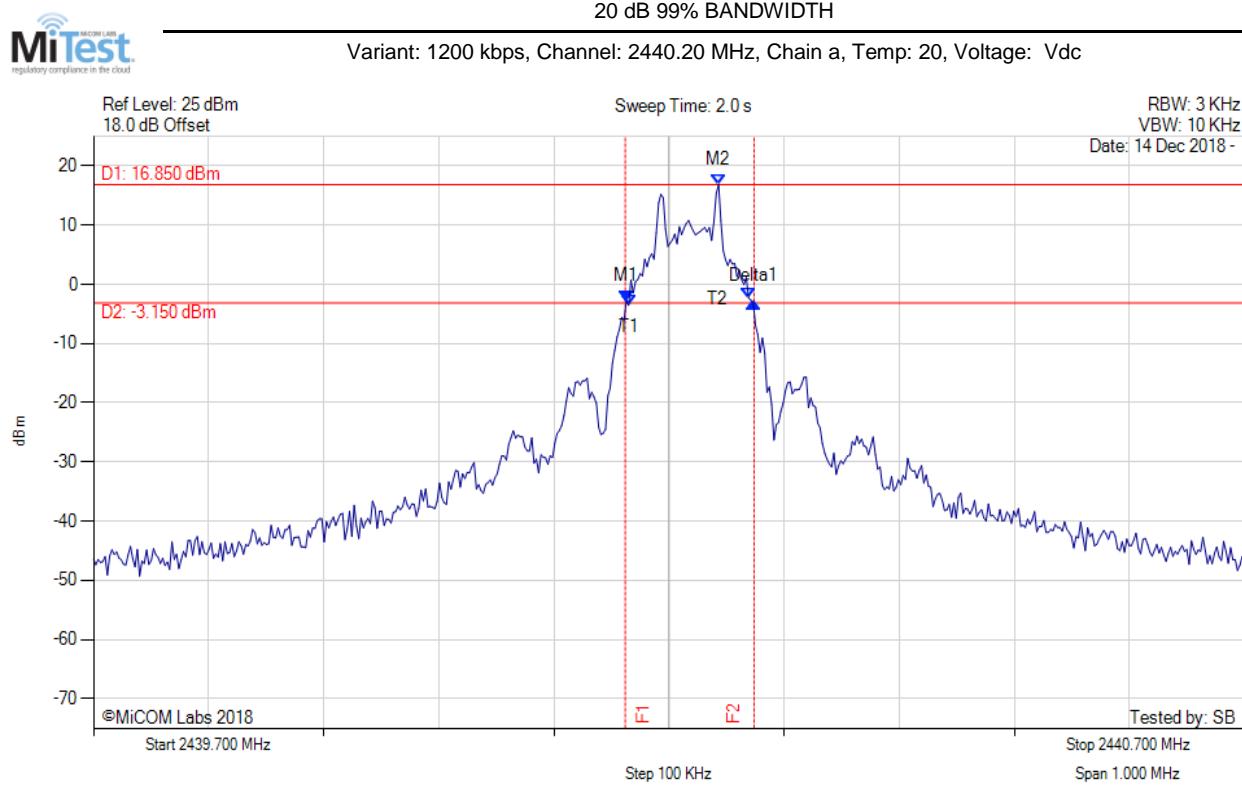
20 dB 99% BANDWIDTH
 Variant: 1200 kbps, Channel: 2401.00 MHz, Chain a, Temp: 20, Voltage: Vdc



Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = MAX HOLD	M1 : 2400.965 MHz : -6.342 dBm M2 : 2400.993 MHz : 15.600 dBm Delta1 : 108 KHz : 1.727 dB T1 : 2400.967 MHz : -2.692 dBm T2 : 2401.071 MHz : -2.488 dBm OBW : 104 KHz	Measured 20 dB Bandwidth: 0.108 MHz Limit: KHz Margin: #VALUE! MHz

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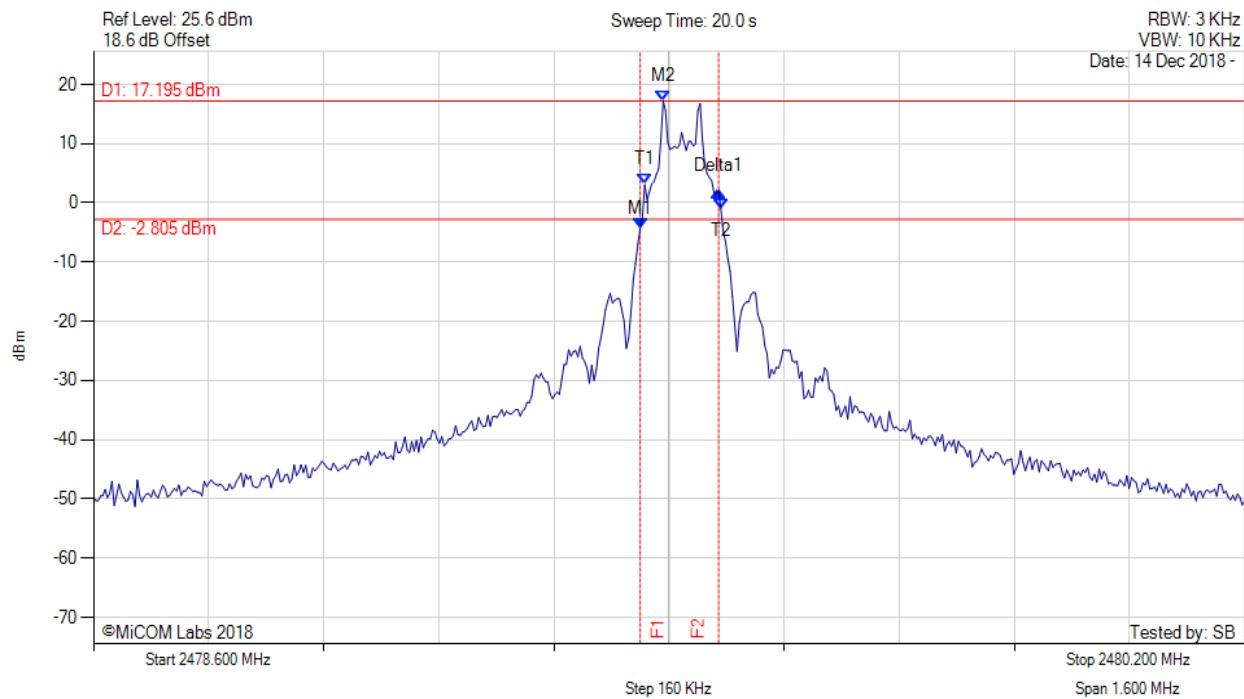
Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = MAX HOLD	M1 : 2440.163 MHz : -2.913 dBm M2 : 2440.243 MHz : 16.853 dBm Delta1 : 110 KHz : -0.043 dB T1 : 2440.165 MHz : -3.550 dBm T2 : 2440.269 MHz : -2.332 dBm OBW : 104 KHz	Measured 20 dB Bandwidth: 0.110 MHz Limit: kHz Margin: #VALUE! MHz

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20 dB 99% BANDWIDTH
 Variant: 1200 kbps, Channel: 2479.40 MHz, Chain a, Temp: 20, Voltage: Vdc



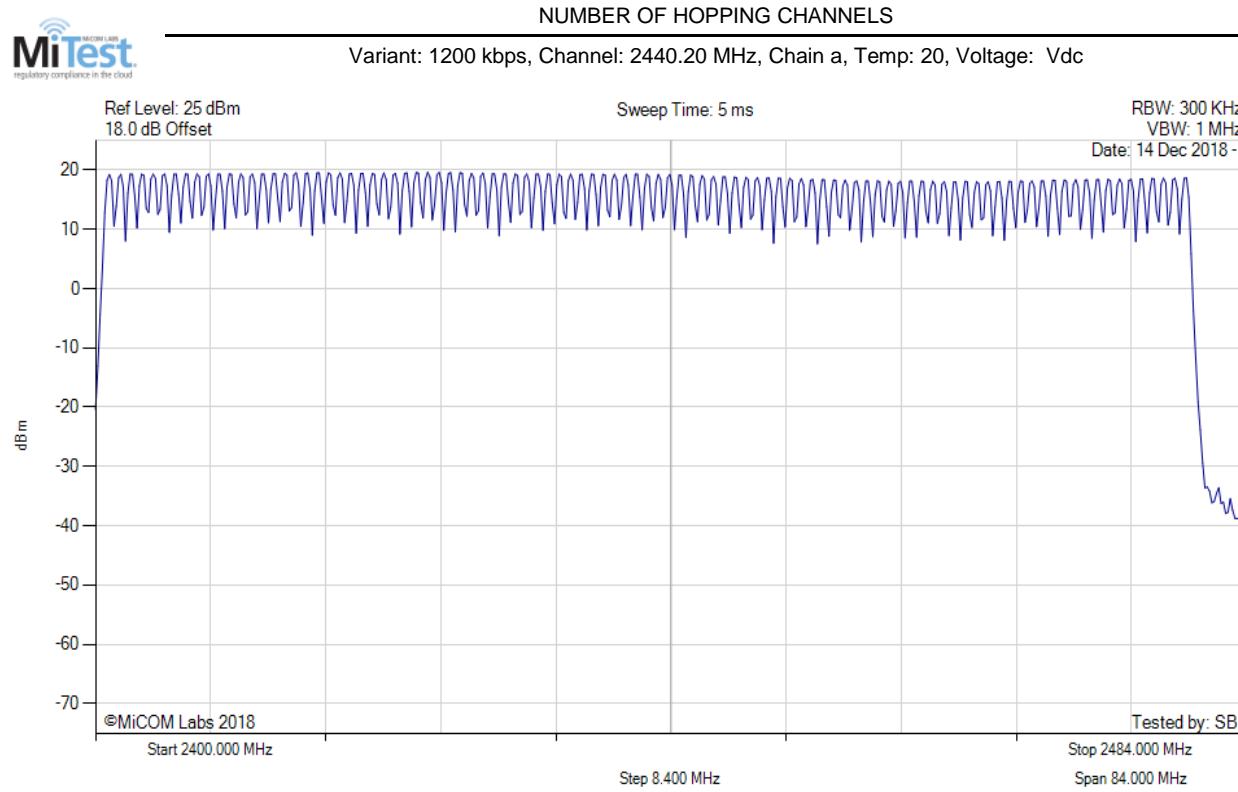
Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = MAX HOLD	M1 : 2479.360 MHz : -4.318 dBm M2 : 2479.392 MHz : 17.195 dBm Delta1 : 109 KHz : 6.368 dB T1 : 2479.366 MHz : 3.064 dBm T2 : 2479.472 MHz : -1.077 dBm OBW : 106 KHz	Measured 20 dB Bandwidth: 0.109 MHz Limit: kHz Margin: #VALUE! MHz

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A.2. Frequency Hopping Tests

A.2.1. Number of Hopping Channels

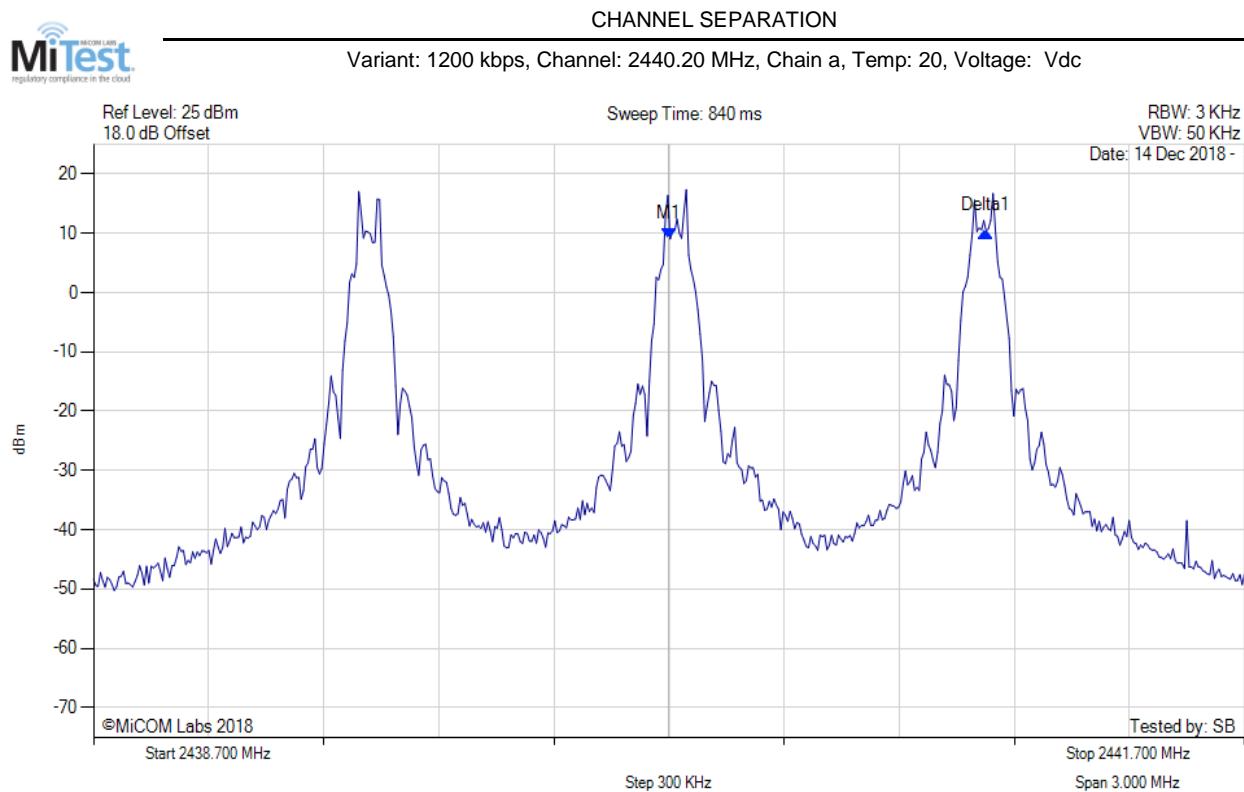


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW		Channel Frequency: 2440.20 MHz

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A.2.2. Channel Separation

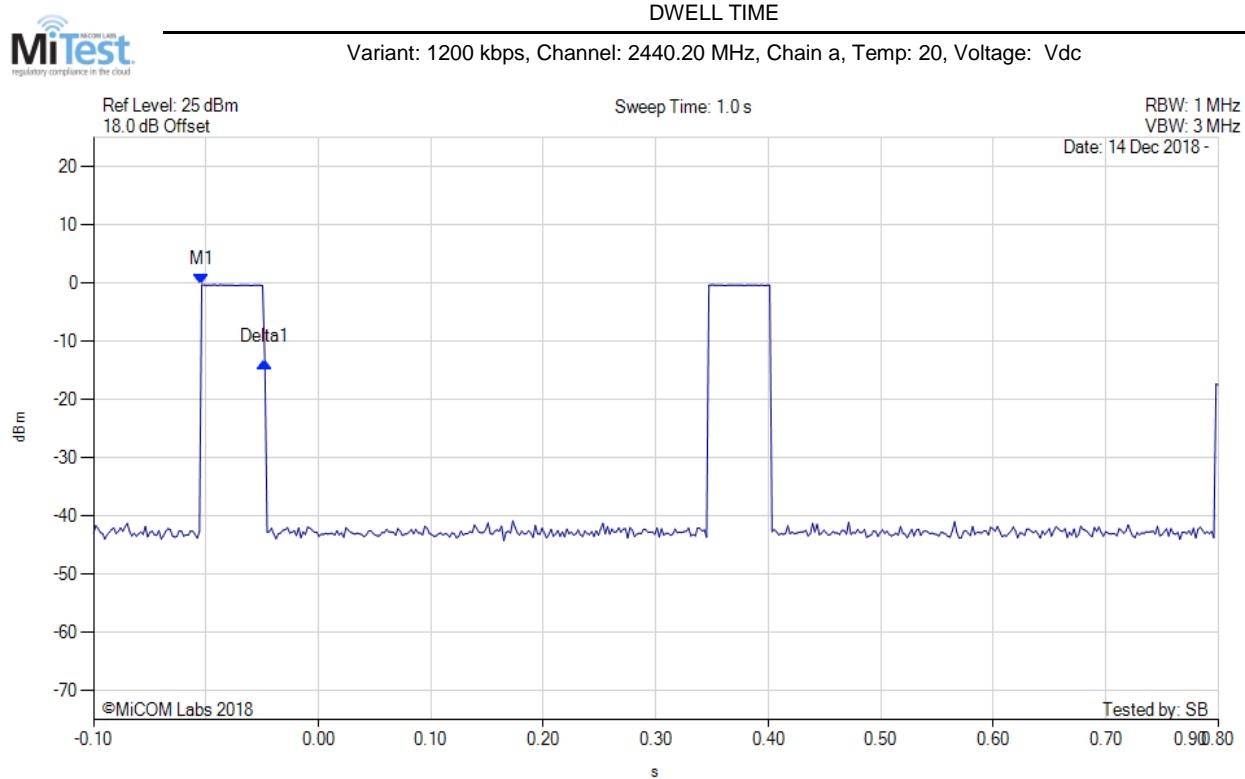


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2440.200 MHz : 9.045 dBm Delta1 : 827 KHz : 1.328 dB	Channel Frequency: 2440.20 MHz

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A.2.3. Dwell Time

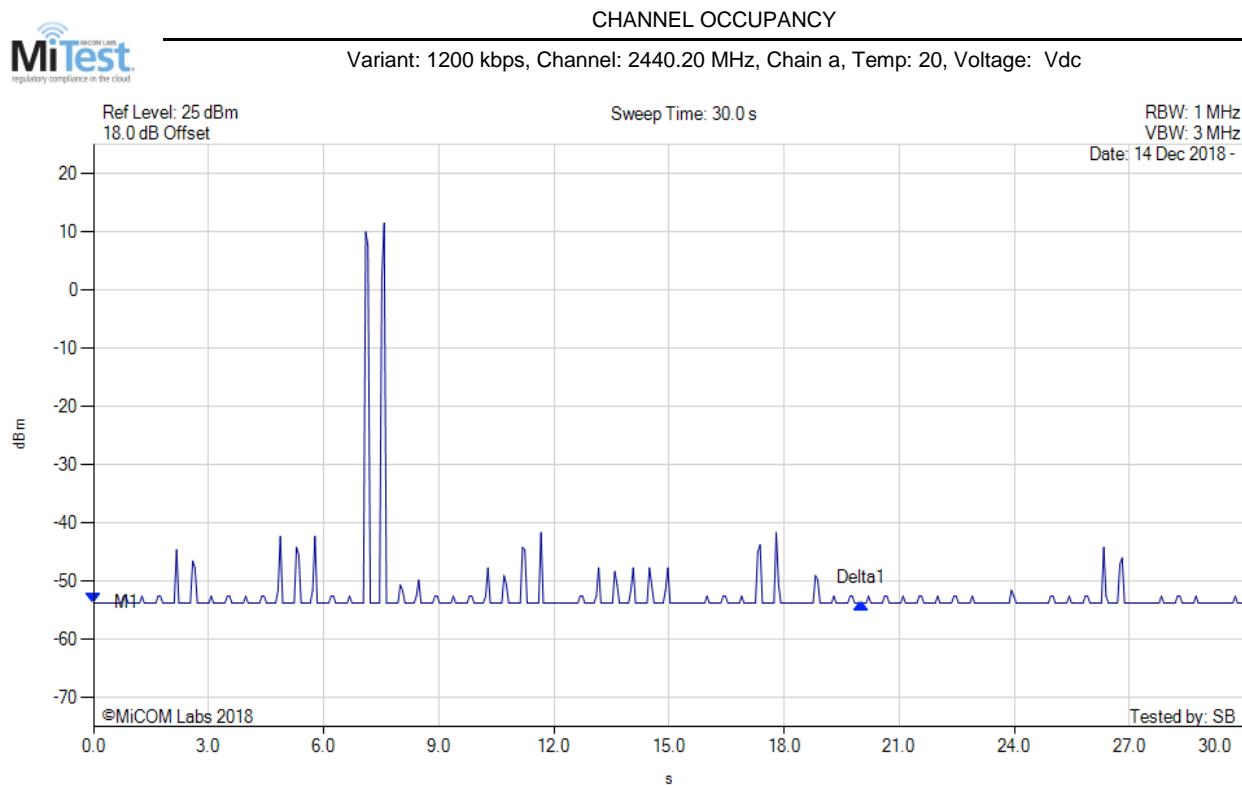


Analyzer Setup	Marker:Time:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1(2440.20 MHz) : -0.004 s : -0.324 dBm Delta1(2440.20 MHz) : 0.056 s : -13.156 dB	Channel Frequency: 2440.20 MHz

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A.2.4. Channel Occupancy



Analyzer Setup	Marker:Time:Amplitude	Test Results
Detector = RMS Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1(2440.20 MHz) : 0.000 s : -53.663 dBm Delta1(2440.20 MHz) : 20.000 s : 0.000 dB	Channel Frequency: 2440.20 MHz

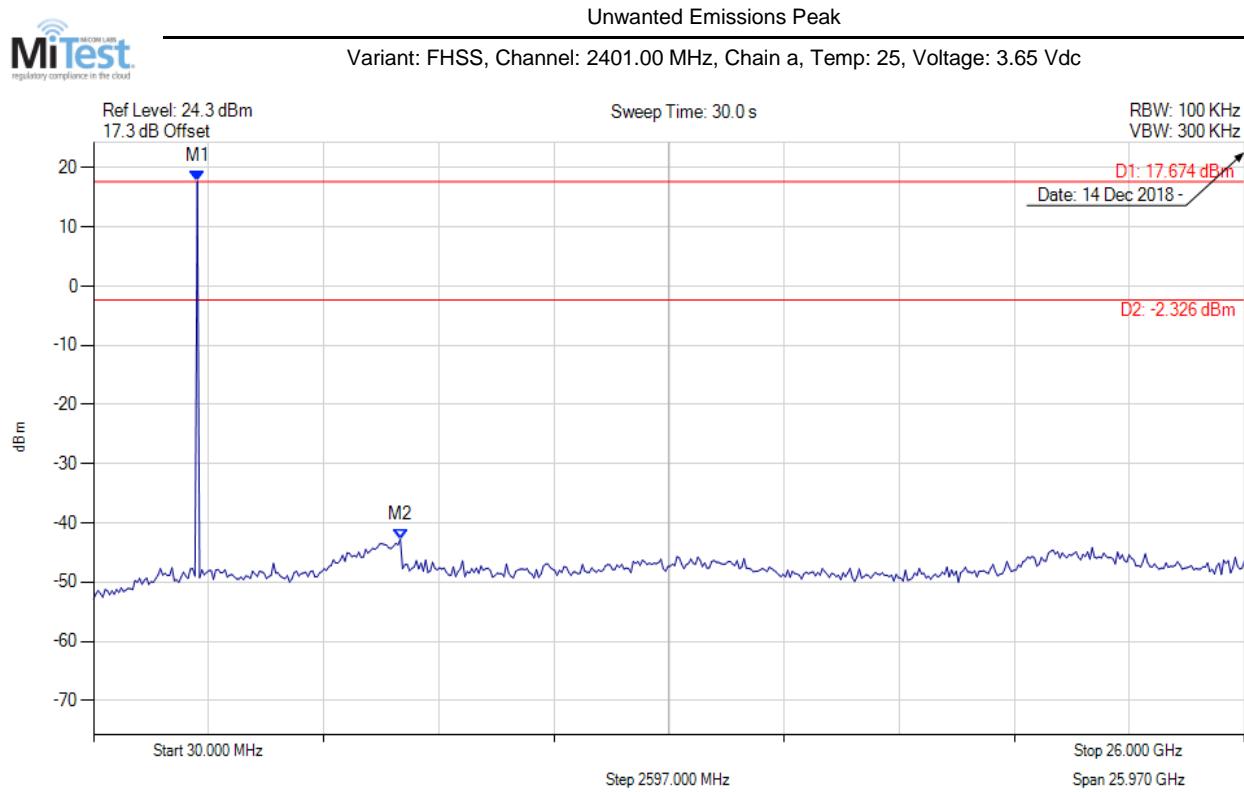
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A.3. Emissions

A.3.1. Conducted Emissions

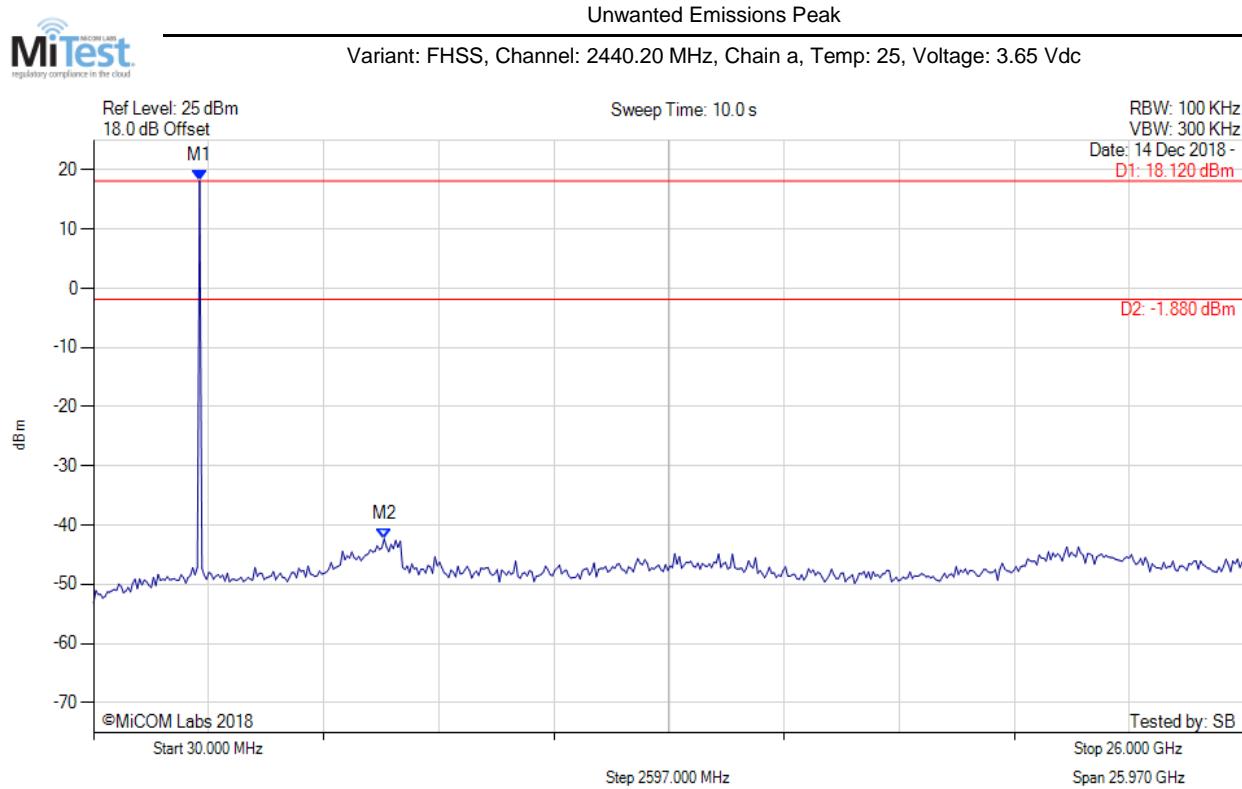
A.3.1.1. Conducted Unwanted Spurious Emissions



Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2371.984 MHz : 17.674 dBm M2 : 6951.864 MHz : -42.722 dBm	Channel Frequency: 2401.00 MHz

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Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = CLR/WRITE	M1 : 2424.028 MHz : 18.124 dBm M2 : 6587.555 MHz : -42.323 dBm	Channel Frequency: 2440.20 MHz

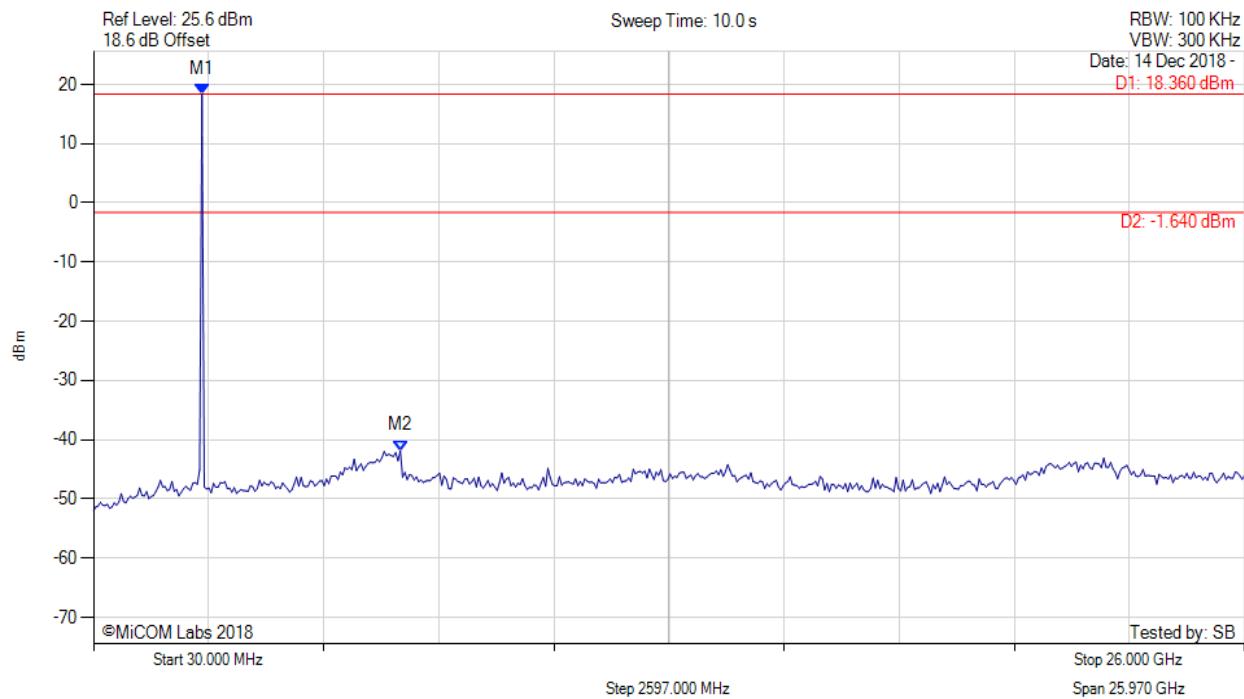
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Unwanted Emissions Peak

Variant: FHSS, Channel: 2479.40 MHz, Chain a, Temp: 25, Voltage: 3.65 Vdc

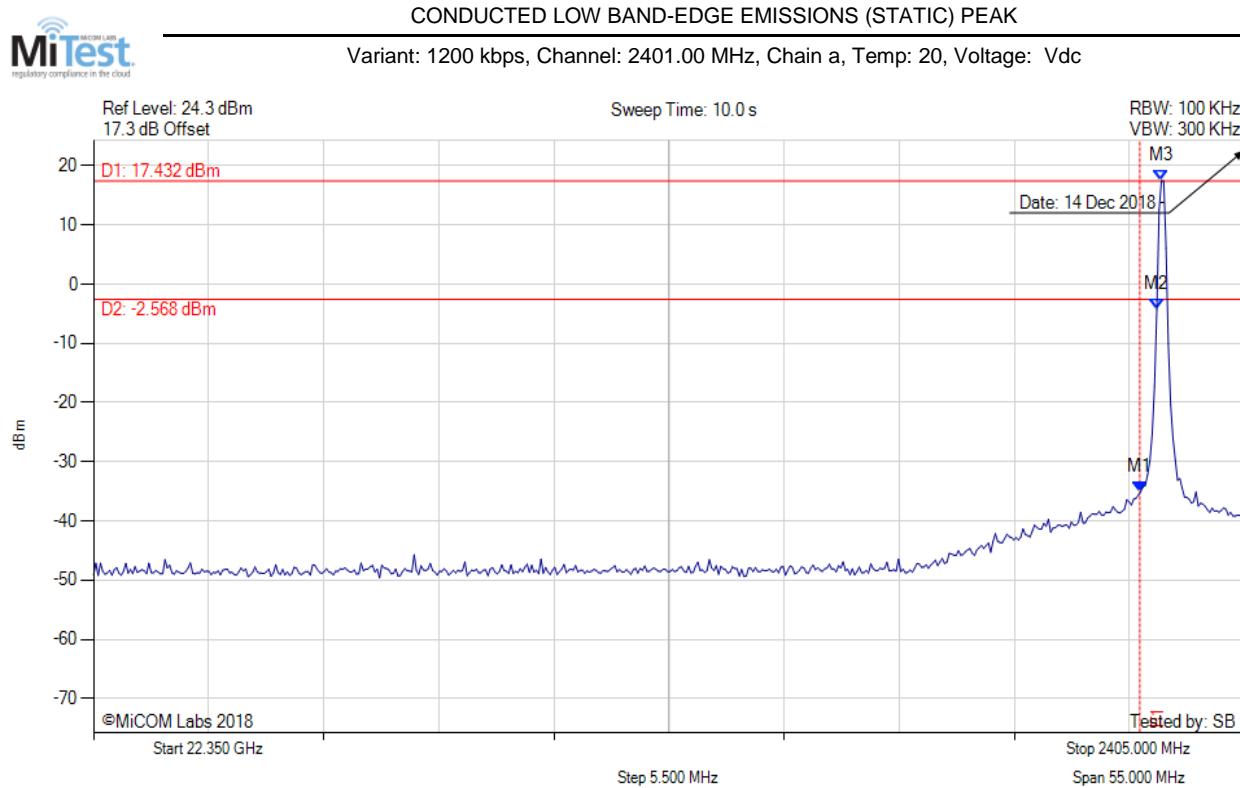


Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = CLR/WRITE	M1 : 2476.072 MHz : 18.360 dBm M2 : 6951.864 MHz : -41.861 dBm	Channel Frequency: 2479.40 MHz

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A.3.1.2. Conducted Band-Edge Emissions



Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2400.000 MHz : -35.053 dBm M2 : 2400.812 MHz : -4.270 dBm M3 : 2401.032 MHz : 17.432 dBm	Channel Frequency: 2401.00 MHz

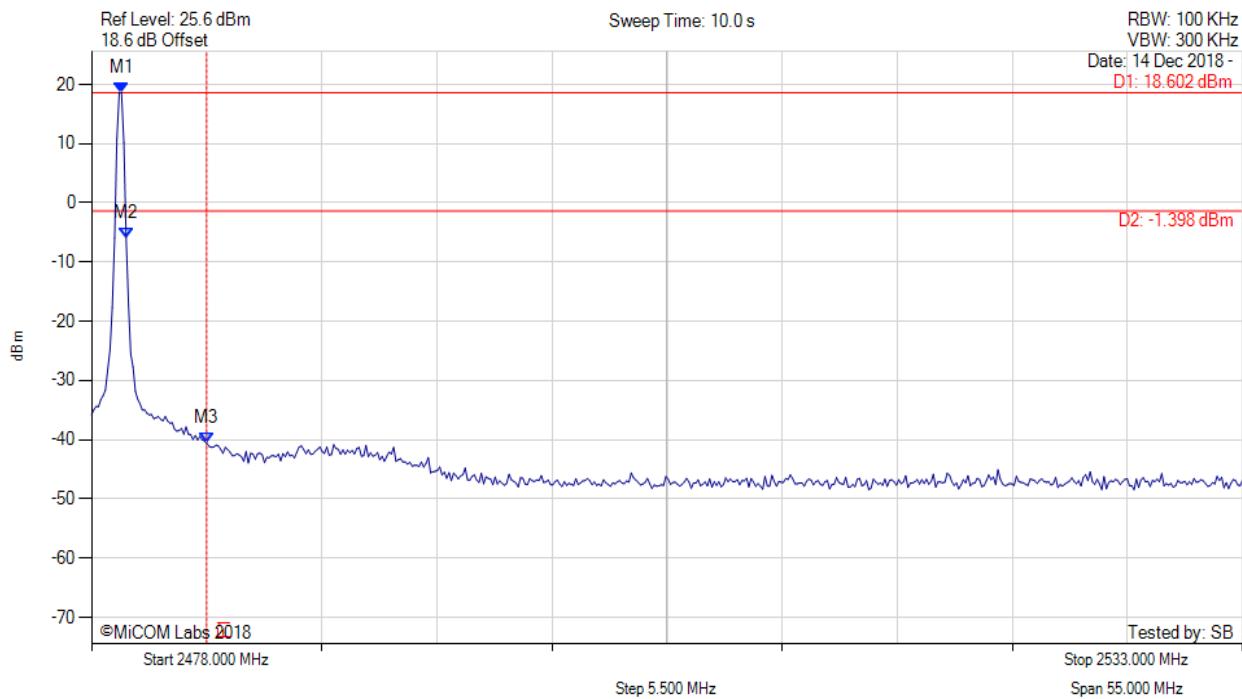
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CONDUCTED UPPER BAND-EDGE EMISSIONS (STATIC) PEAK

Variant: 1200 kbps, Channel: 2479.40 MHz, Chain a, Temp: 20, Voltage: Vdc



Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2479.433 MHz : 18.602 dBm M2 : 2479.653 MHz : -5.911 dBm M3 : 2483.500 MHz : -40.627 dBm	Channel Frequency: 2479.40 MHz

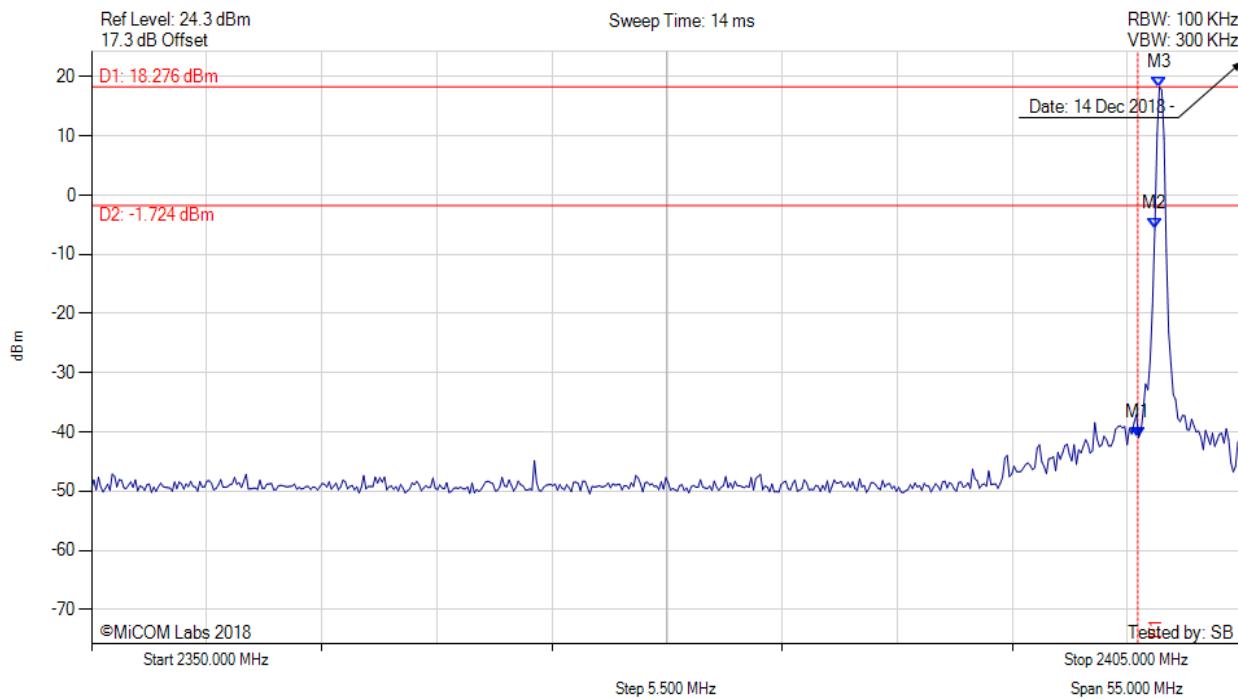
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CONDUCTED LOW BAND-EDGE EMISSIONS (HOPPING) PEAK

Variant: 1200 kbps, Channel: 2401.00 MHz, Chain a, Temp: 20, Voltage: Vdc



Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2400.000 MHz : -40.957 dBm M2 : 2400.812 MHz : -5.714 dBm M3 : 2401.032 MHz : 18.276 dBm	Channel Frequency: 2401.00 MHz

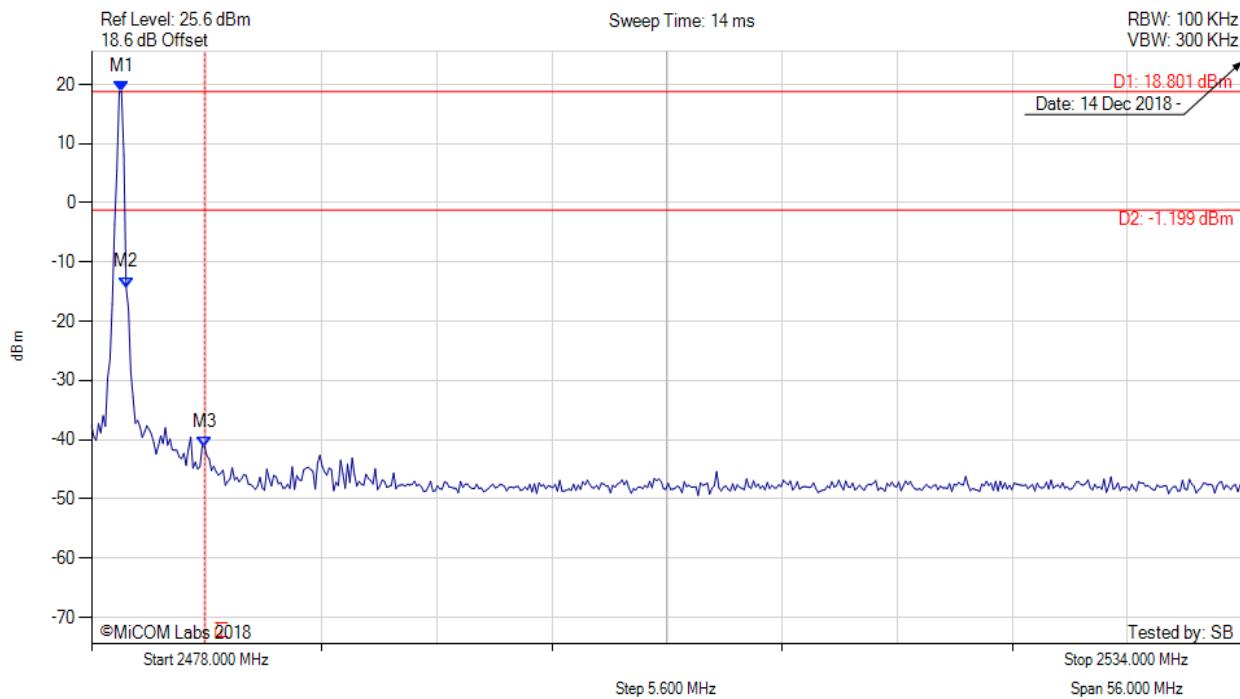
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CONDUCTED UPPER BAND-EDGE EMISSIONS (HOPPING) PEAK

Variant: 1200 kbps, Channel: 2479.40 MHz, Chain a, Temp: 20, Voltage: Vdc



Analyzer Setup	Marker:Frequency:Amplitude	Test Results
Detector = MAX PEAK Sweep Count = 0 RF Atten (dB) = 20 Trace Mode = VIEW	M1 : 2479.459 MHz : 18.801 dBm M2 : 2479.683 MHz : -14.288 dBm M3 : 2483.500 MHz : -41.170 dBm	Channel Frequency: 2479.40 MHz

[back to matrix](#)

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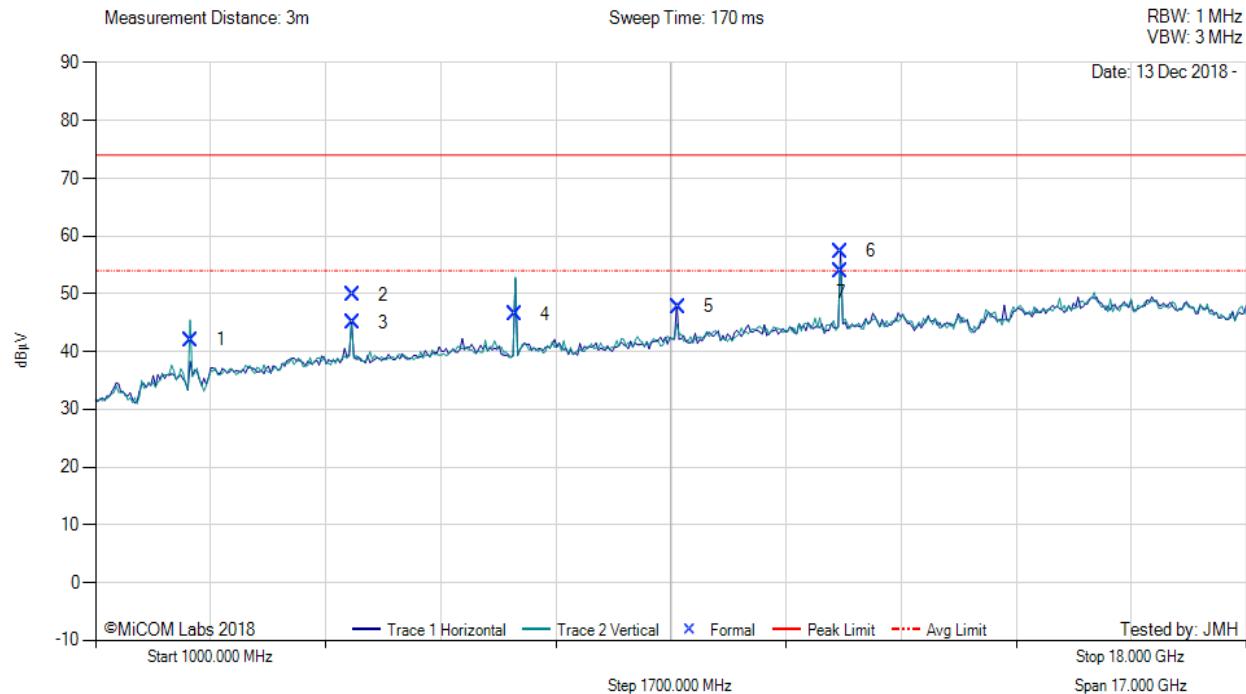
A.3.2. Radiated Emissions

A.3.2.3. TX Spurious & Restricted Band Emissions



TX SPURIOUS & RESTRICTED BAND EMISSIONS

Variant: FHSS, Test Freq: 2401.00 MHz, Antenna: Shoof Tech. FHSS Antenna, Power Setting: 13



1000.00 - 18000.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
1	2400.17	56.21	-1.76	-12.42	42.03	Fundamental	Vertical	100	0	--	--		
2	4800.42	64.84	-2.56	-12.46	49.82	Max Peak	Horizontal	122	236	74.0	-24.2	Pass	
3	4800.42	60.09	-2.56	-12.46	45.07	Max Avg	Horizontal	122	236	54.0	-8.9	Pass	
4	7200.56	56.87	-3.00	-7.37	46.50	Peak (NRB)	Vertical	100	0	--	--	Pass	
5	9600.80	58.48	-3.90	-6.82	47.76	Peak (NRB)	Horizontal	100	0	--	--	Pass	
6	12000.93	68.59	-4.12	-7.10	57.37	Max Peak	Horizontal	196	328	74.0	-16.6	Pass	
7	12000.93	65.10	-4.12	-7.10	53.88	Max Avg	Horizontal	196	328	54.0	-0.1	Pass	

Test Notes: EUT powered by DC Linear PS. 2.4 G notch in front of amp to prevent overload.

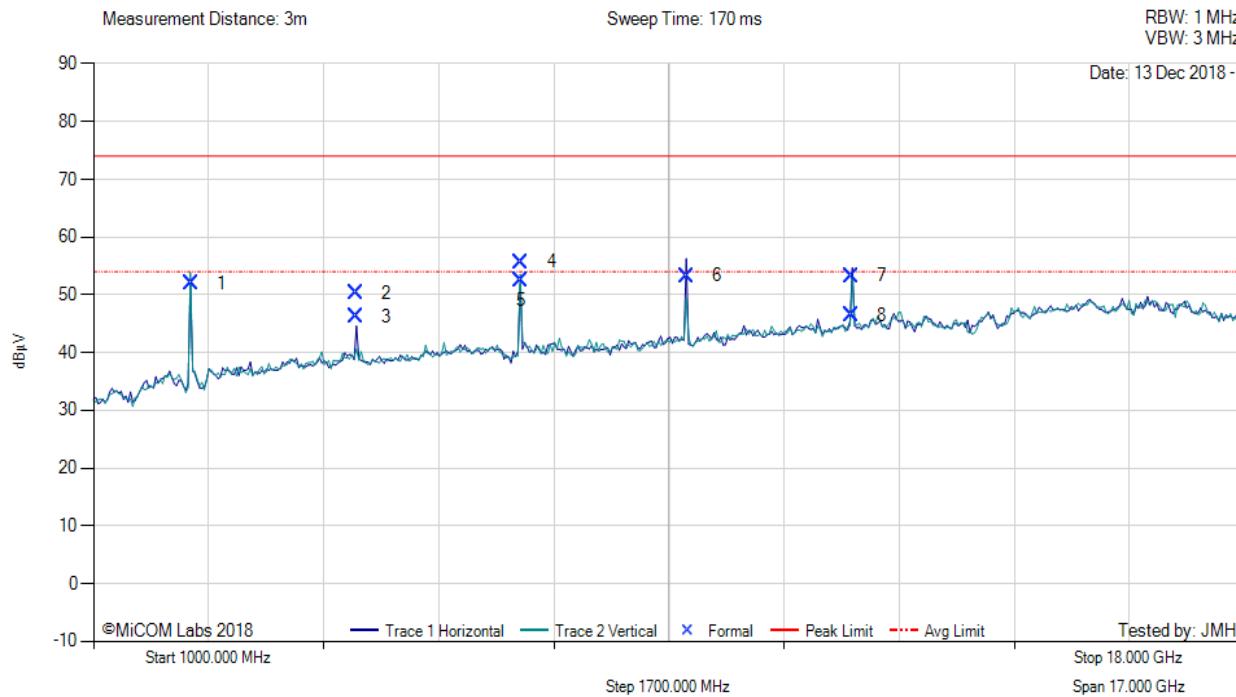
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TX SPURIOUS & RESTRICTED BAND EMISSIONS

Variant: FHSS, Test Freq: 2440.20 MHz, Antenna: Shoof Tech. FHSS Antenna, Power Setting: 12



1000.00 - 18000.00 MHz													
Num	Frequency MHz	Raw dBµV	Cable Loss dB	AF dB/m	Level dBµV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBµV/m	Margin dB	Pass /Fail	
1	2440.20	65.88	-1.79	-12.08	52.01	Fundamental	Vertical	100	0	--	--		
2	4880.39	65.31	-2.50	-12.50	50.31	Max Peak	Horizontal	130	250	74.0	-23.7	Pass	
3	4880.39	61.23	-2.50	-12.50	46.23	Max Avg	Horizontal	130	250	54.0	-7.8	Pass	
4	7320.55	66.53	-3.00	-7.86	55.67	Max Peak	Vertical	130	76	74.0	-18.3	Pass	
5	7320.55	63.45	-3.00	-7.86	52.59	Max Avg	Vertical	130	76	54.0	-1.4	Pass	
6	9760.79	62.94	-3.69	-5.93	53.32	Peak (NRB)	Horizontal	100	0	--	--	Pass	
7	12201.03	62.32	-4.30	-4.77	53.25	Max Peak	Horizontal	136	161	74.0	-20.8	Pass	
8	12201.03	55.47	-4.30	-4.77	46.40	Max Avg	Horizontal	136	161	54.0	-7.6	Pass	

Test Notes: Powered by DC Linear PS. 2.4G notch in front of amp to prevent overload.

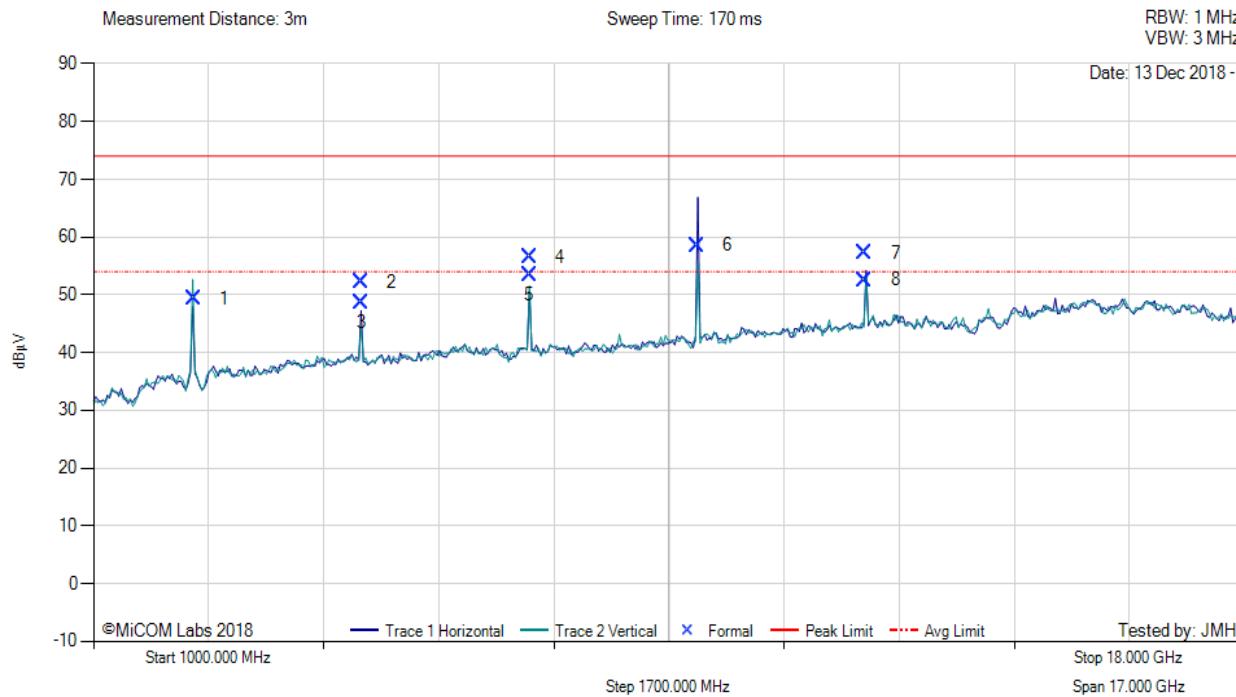
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TX SPURIOUS & RESTRICTED BAND EMISSIONS

Variant: FHSS, Test Freq: 2479.40 MHz, Antenna: Shoof Tech. FHSS Antenna, Power Setting: 15



1000.00 - 18000.00 MHz													
Num	Frequency MHz	Raw dBµV	Cable Loss dB	AF dB/m	Level dBµV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBµV/m	Margin dB	Pass /Fail	
1	2479.39	63.72	-1.77	-12.60	49.35	Fundamental	Vertical	100	0	--	--		
2	4958.69	66.86	-2.55	-12.10	52.21	Max Peak	Horizontal	105	298	74.0	-21.8	Pass	
3	4958.69	63.38	-2.55	-12.10	48.73	Max Avg	Horizontal	105	298	54.0	-5.3	Pass	
4	7438.22	67.48	-3.00	-8.04	56.44	Max Peak	Vertical	142	85	74.0	-17.6	Pass	
5	7438.22	64.53	-3.00	-8.04	53.49	Max Avg	Vertical	142	85	54.0	-0.5	Pass	
6	9917.40	69.27	-3.73	-6.97	58.57	Peak (NRB)	Horizontal	100	0	--	--	Pass	
7	12396.93	67.15	-4.12	-5.79	57.24	Max Peak	Horizontal	196	160	74.0	-16.8	Pass	
8	12396.93	62.50	-4.12	-5.79	52.59	Max Avg	Horizontal	196	160	54.0	-1.4	Pass	

Test Notes: Powered by DC Linear PS. 2.4G notch in front of amp to prevent overload.

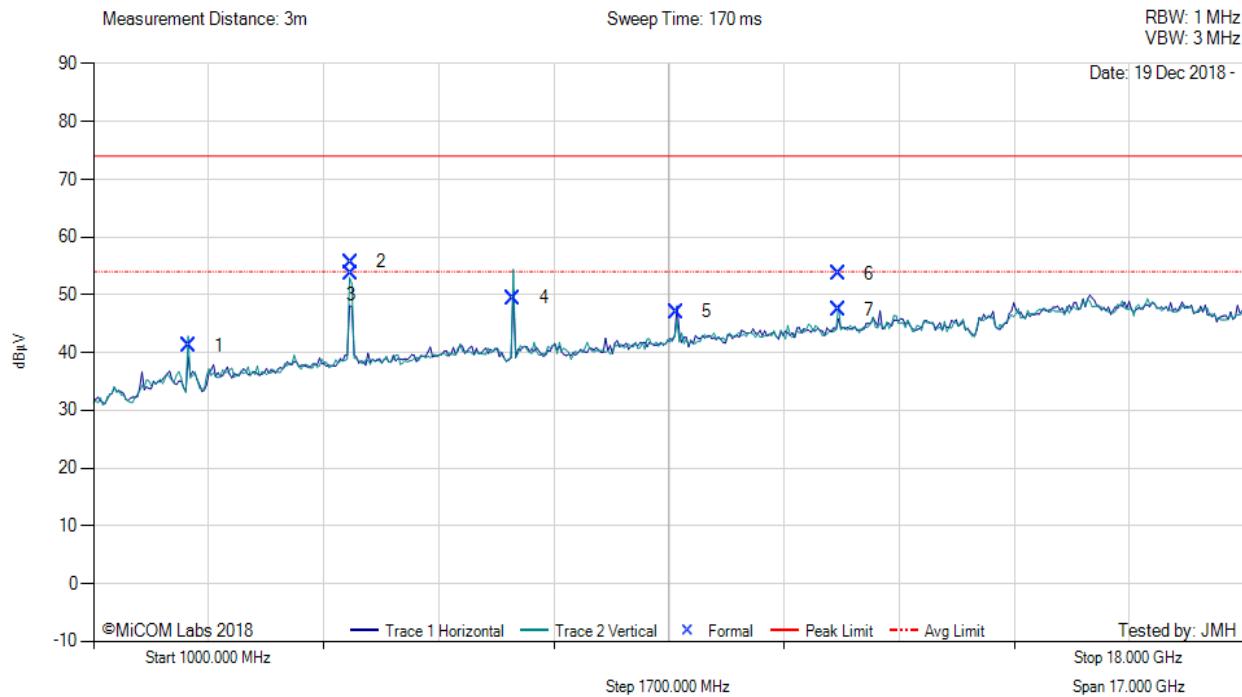
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TX SPURIOUS & RESTRICTED BAND EMISSIONS

Variant: FHSS, Test Freq: 2401.00 MHz, Antenna: WP WPANT30211-S1A, Power Setting: 13



1000.00 - 18000.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
1	2401.87	55.31	-1.76	-12.41	41.14	Fundamental	Vertical	100	0	--	--		
2	4803.59	70.57	-2.55	-12.38	55.64	Max Peak	Vertical	119	68	74.0	-18.4	Pass	
3	4803.59	68.50	-2.55	-12.38	53.57	Max Avg	Vertical	119	68	54.0	-0.4	Pass	
4	7205.55	59.79	-3.01	-7.37	49.41	Peak (NRB)	Vertical	100	0	--	--	Pass	
5	9607.49	57.59	-3.92	-6.64	47.03	Peak (NRB)	Horizontal	100	0	--	--	Pass	
6	12009.18	64.88	-4.20	-7.08	53.60	Max Peak	Vertical	111	159	74.0	-20.4	Pass	
7	12009.18	58.68	-4.20	-7.08	47.40	Max Avg	Vertical	111	159	54.0	-6.6	Pass	

Test Notes: EUT powered by DC Linear PS. 2.4G Notch in front of amp to prevent overload

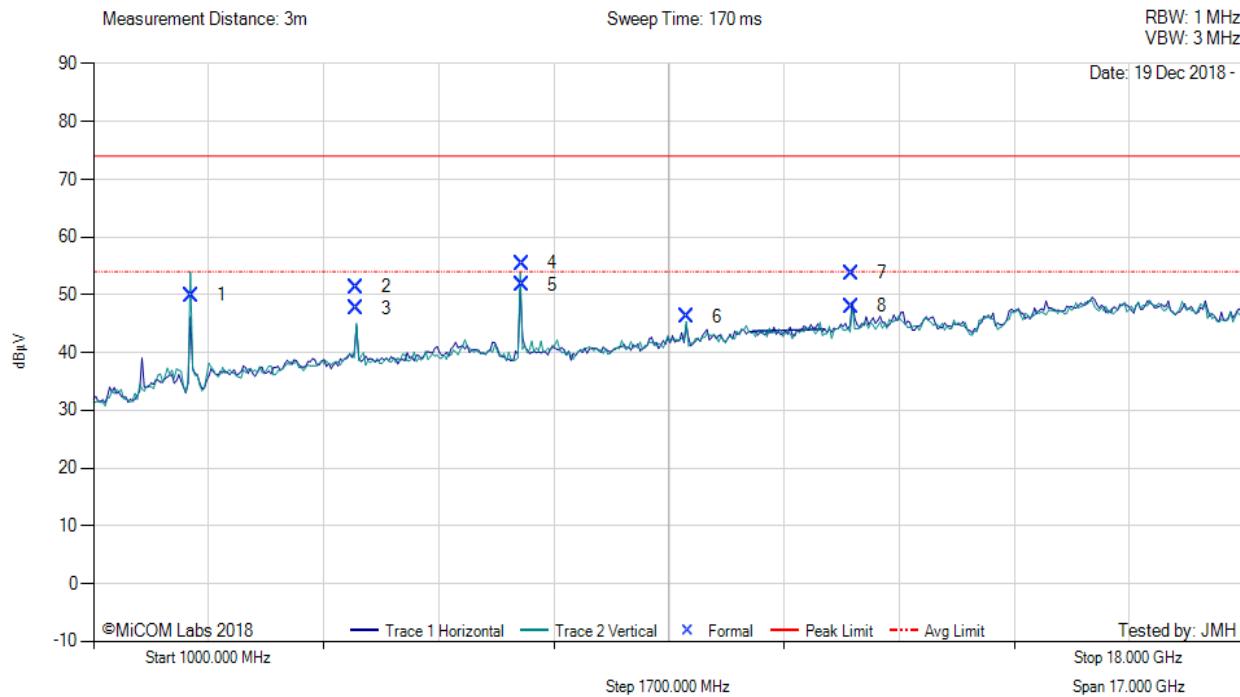
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TX SPURIOUS & RESTRICTED BAND EMISSIONS

Variant: FHSS, Test Freq: 2440.20 MHz, Antenna: WP WPANT30211-S1A, Power Setting: 13



1000.00 - 18000.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
1	2440.19	63.80	-1.79	-12.08	49.93	Fundamental	Vertical	100	0	--	--		
2	4880.43	66.34	-2.50	-12.50	51.34	Max Peak	Vertical	153	19	74.0	-22.7	Pass	
3	4880.43	62.64	-2.50	-12.50	47.64	Max Avg	Vertical	153	19	54.0	-6.4	Pass	
4	7320.76	66.28	-3.00	-7.86	55.42	Max Peak	Vertical	139	319	74.0	-18.6	Pass	
5	7320.76	62.57	-3.00	-7.86	51.71	Max Avg	Vertical	139	319	54.0	-2.3	Pass	
6	9760.92	55.88	-3.69	-5.93	46.26	Peak (NRB)	Vertical	151	129	--	--	Pass	
7	12201.10	62.85	-4.30	-4.77	53.78	Max Peak	Horizontal	150	24	74.0	-20.2	Pass	
8	12201.10	57.09	-4.30	-4.77	48.02	Max Avg	Horizontal	150	24	54.0	-6.0	Pass	

Test Notes: EUT powered by DC Linear PS. 2.4G Notch in front of amp to prevent overload

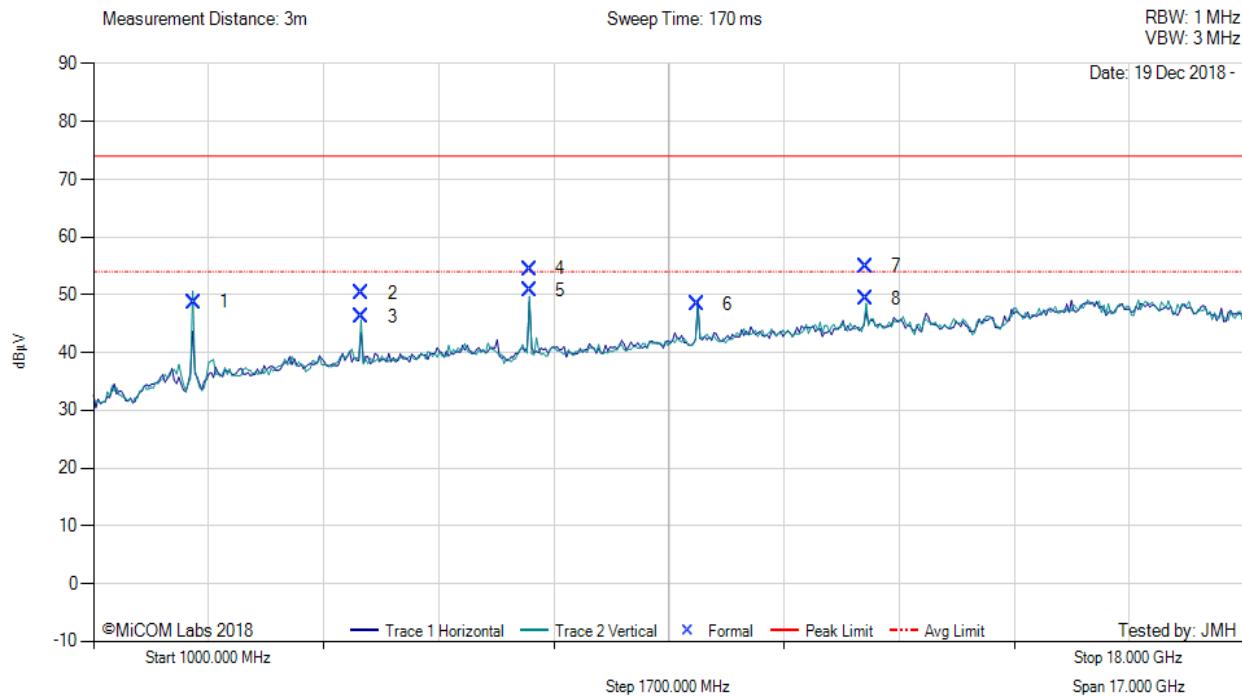
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TX SPURIOUS & RESTRICTED BAND EMISSIONS

Variant: FHSS, Test Freq: 2479.40 MHz, Antenna: WP WPANT30211-S1A, Power Setting: 13



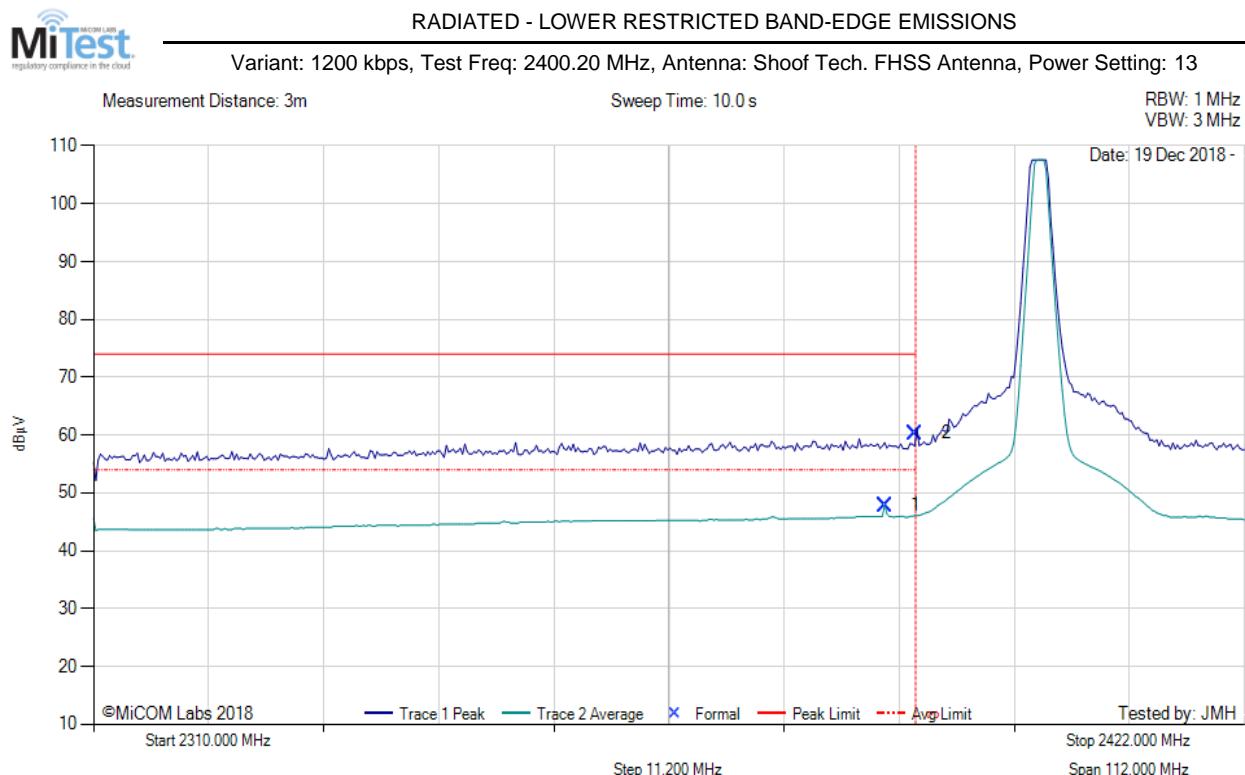
1000.00 - 18000.00 MHz													
Num	Frequency MHz	Raw dBµV	Cable Loss dB	AF dB/m	Level dBµV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBµV/m	Margin dB	Pass /Fail	
1	2480.24	62.41	-1.77	-11.87	48.77	Fundamental	Vertical	151	0	--	--		
2	4960.44	64.94	-2.55	-12.13	50.26	Max Peak	Vertical	160	14	74.0	-23.7	Pass	
3	4960.44	60.87	-2.55	-12.13	46.19	Max Avg	Vertical	160	14	54.0	-7.8	Pass	
4	7440.73	65.48	-3.00	-8.01	54.47	Max Peak	Vertical	141	109	74.0	-19.5	Pass	
5	7440.73	61.84	-3.00	-8.01	50.83	Max Avg	Vertical	141	109	54.0	-3.2	Pass	
6	9920.97	59.10	-3.73	-6.96	48.41	Peak (NRB)	Horizontal	151	0	--	--	Pass	
7	12401.07	65.12	-4.15	-6.00	54.97	Max Peak	Vertical	125	16	74.0	-19.0	Pass	
8	12401.07	59.44	-4.15	-6.00	49.29	Max Avg	Vertical	125	16	54.0	-4.7	Pass	

Test Notes: EUT powered by DC Linear PS. 2.4G Notch in front of amp to prevent overload

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A.3.2.4. Restricted Edge & Band-Edge Emissions



2310.00 - 2422.00 MHz													
Num	Frequency MHz	Raw dBμV	Cable Loss dB	AF dB/m	Level dBμV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBμV/m	Margin dB	Pass /Fail	
1	2386.99	17.74	-1.77	31.94	47.91	Max Avg	Vertical	116	221	54.0	-6.1	Pass	
2	2390.00	30.19	-1.77	31.93	60.35	Max Peak	Vertical	116	221	74.0	-13.7	Pass	
3	2390.00	--	--	--	--	Restricted-Band	--	--	--	--	--	--	

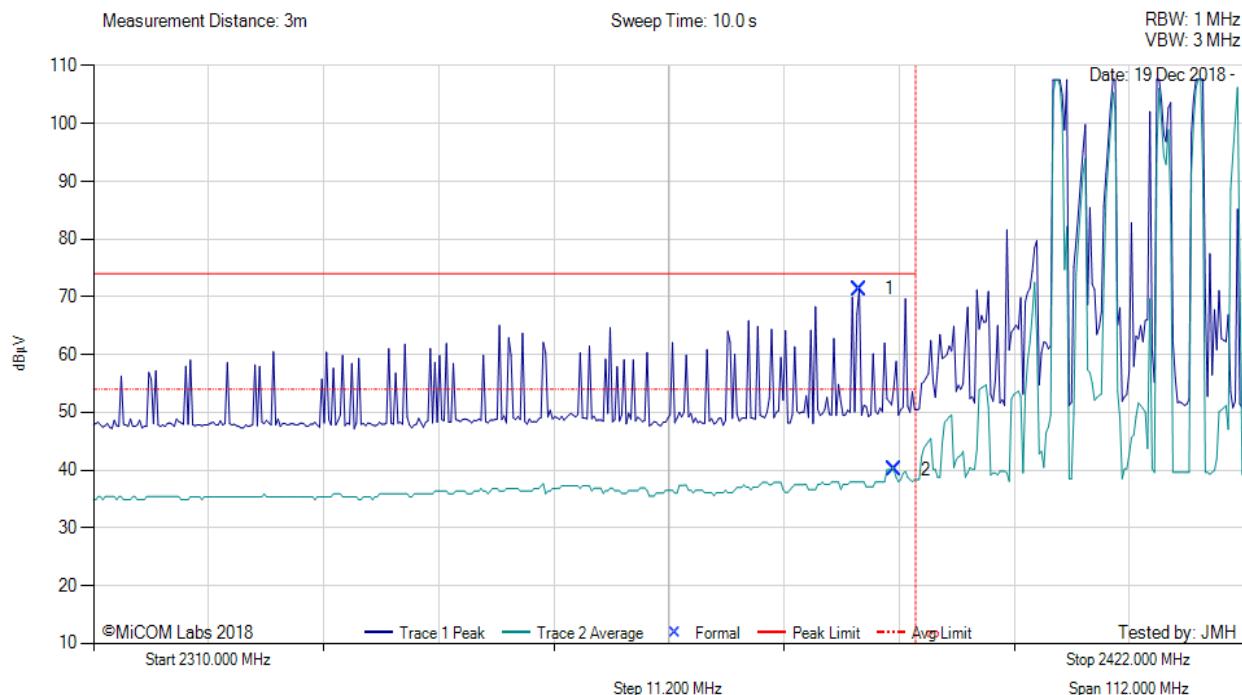
Test Notes: EUT powered by DC Linear PS.

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RADIATED - LOWER RESTRICTED BAND-EDGE EMISSIONS

Variant: 2000 kbps, Test Freq: 0.00 MHz, Antenna: Shoof Tech. FHSS Antenna, Power Setting: 13



2310.00 - 2422.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
1	2384.52	41.20	-1.77	31.93	71.36	Max Peak	Vertical	116	221	74.0	-2.6	Pass	
2	2387.98	9.91	-1.77	31.95	40.09	Max Avg	Vertical	116	221	54.0	-13.9	Pass	
3	2390.00	--	--	--	--	Restricted-Band	--	--	--	--	--	--	

Test Notes: EUT powered by DC Linear PS. Hopping

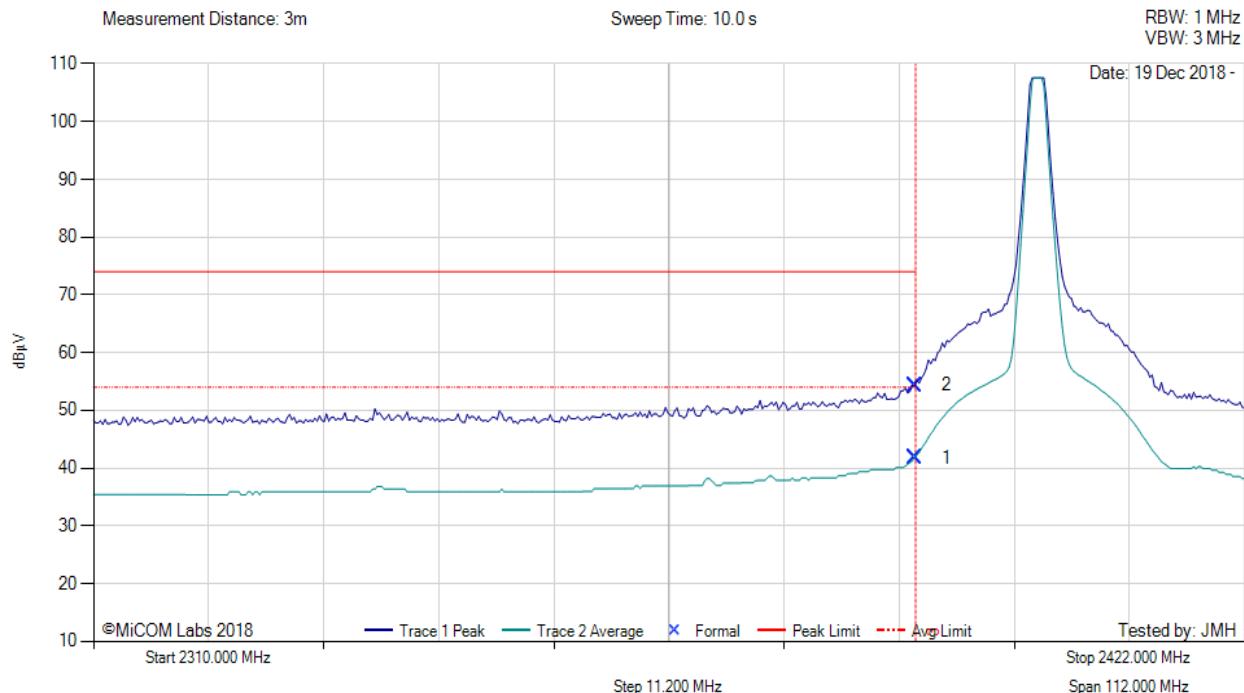
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RADIATED - LOWER RESTRICTED BAND-EDGE EMISSIONS

Variant: 1200 kbps, Test Freq: 2400.20 MHz, Antenna: WP WPANT30211-S1A, Power Setting: 19



2310.00 - 2422.00 MHz													
Num	Frequency MHz	Raw dB _µ V	Cable Loss dB	AF dB/m	Level dB _µ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB _µ V/m	Margin dB	Pass /Fail	
1	2390.00	11.60	-1.77	31.96	41.79	Max Avg	Vertical	143	176	54.0	-12.2	Pass	
2	2390.00	24.20	-1.77	31.96	54.39	Max Peak	Vertical	143	176	74.0	-19.6	Pass	
3	2390.00	--	--	--	--	Restricted-Band	--	--	--	--	--	--	

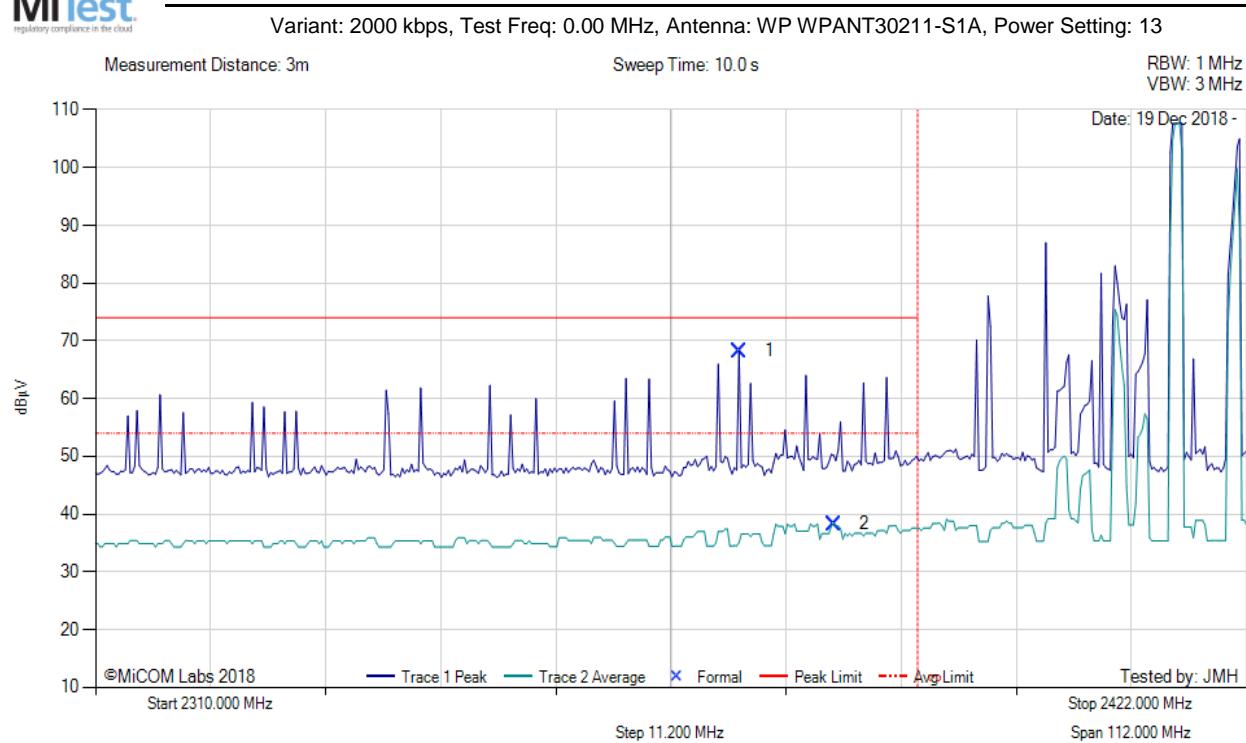
Test Notes: EUT powered by DC Linear PS.

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RADIATED - LOWER RESTRICTED BAND-EDGE EMISSIONS



2310.00 - 2422.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
1	2372.62	36.40	0.00	31.87	68.27	Max Peak	Vertical	143	176	74.0	-5.7	Pass	
2	2381.82	8.17	-1.76	31.92	38.33	Max Avg	Vertical	143	176	54.0	-15.7	Pass	
3	2390.00	--	--	--	--	Restricted-Band	--	--	--	--	--	--	

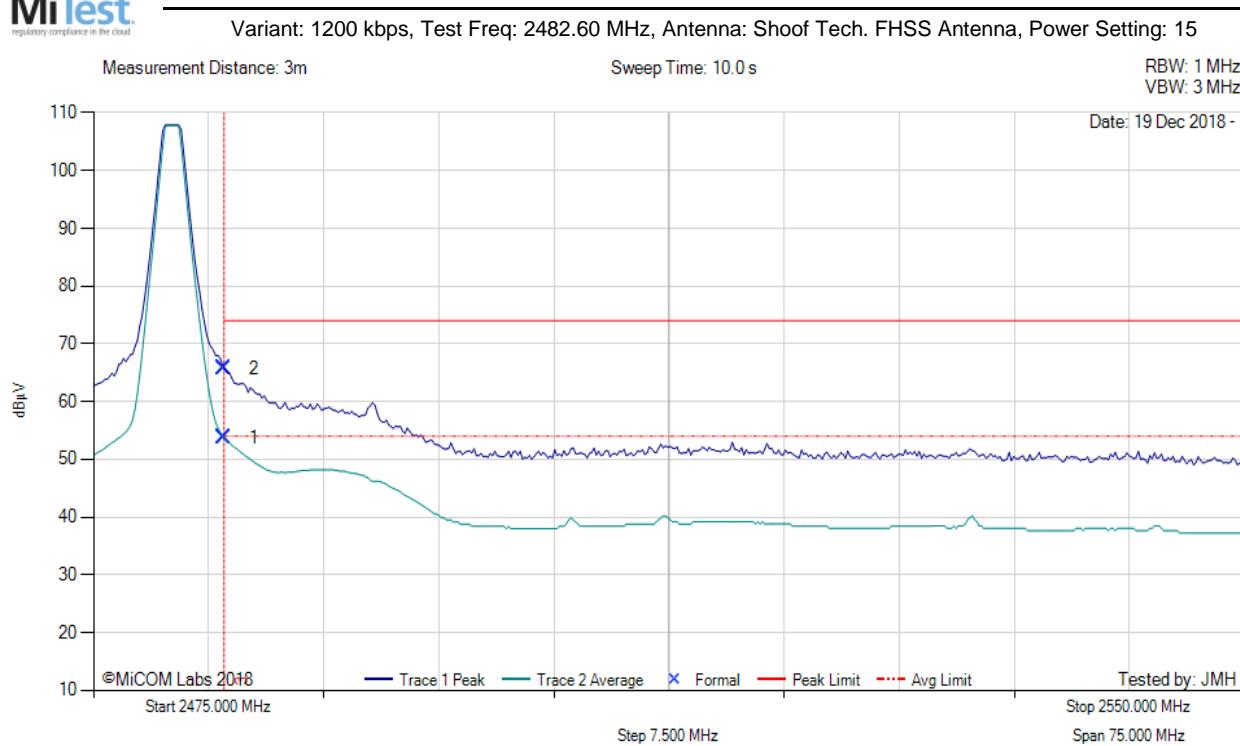
Test Notes: EUT powered by DC Linear PS. Hopping

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RADIATED - UPPER RESTRICTED BAND-EDGE EMISSIONS



2475.00 - 2550.00 MHz													
Num	Frequency MHz	Raw dBµV	Cable Loss dB	AF dB/m	Level dBµV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBµV/m	Margin dB	Pass /Fail	
1	2483.50	23.13	-1.78	32.33	53.68	Max Avg	Vertical	116	221	54.0	-0.3	Pass	
2	2483.50	35.12	-1.78	32.33	65.67	Max Peak	Vertical	116	221	74.0	-8.3	Pass	
3	2483.50	--	--	--	--	Restricted-Band	--	--	--	--	--	--	

Test Notes: EUT powered by DC Linear PS.

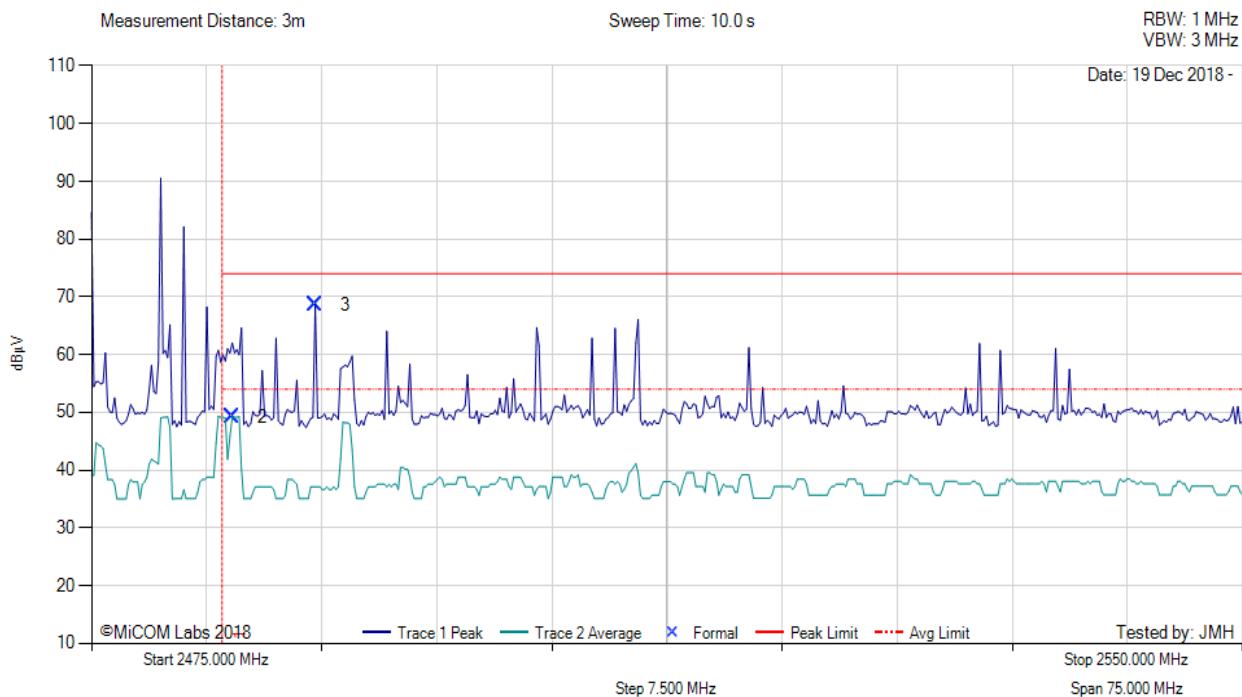
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RADIATED - UPPER RESTRICTED BAND-EDGE EMISSIONS

Variant: 2000 kbps, Test Freq: 0.00 MHz, Antenna: Shoof Tech. FHSS Antenna, Power Setting: 13



2475.00 - 2550.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
2	2484.17	18.61	-1.78	32.33	49.16	Max Avg	Vertical	116	221	54.0	-4.8	Pass	
3	2489.58	38.12	-1.78	32.32	68.66	Max Peak	Vertical	116	221	74.0	-5.3	Pass	
1	2483.50	--	--	--	--	Restricted-Band	--	--	--	--	--	--	

Test Notes: EUT powered by DC Linear PS. Hopping

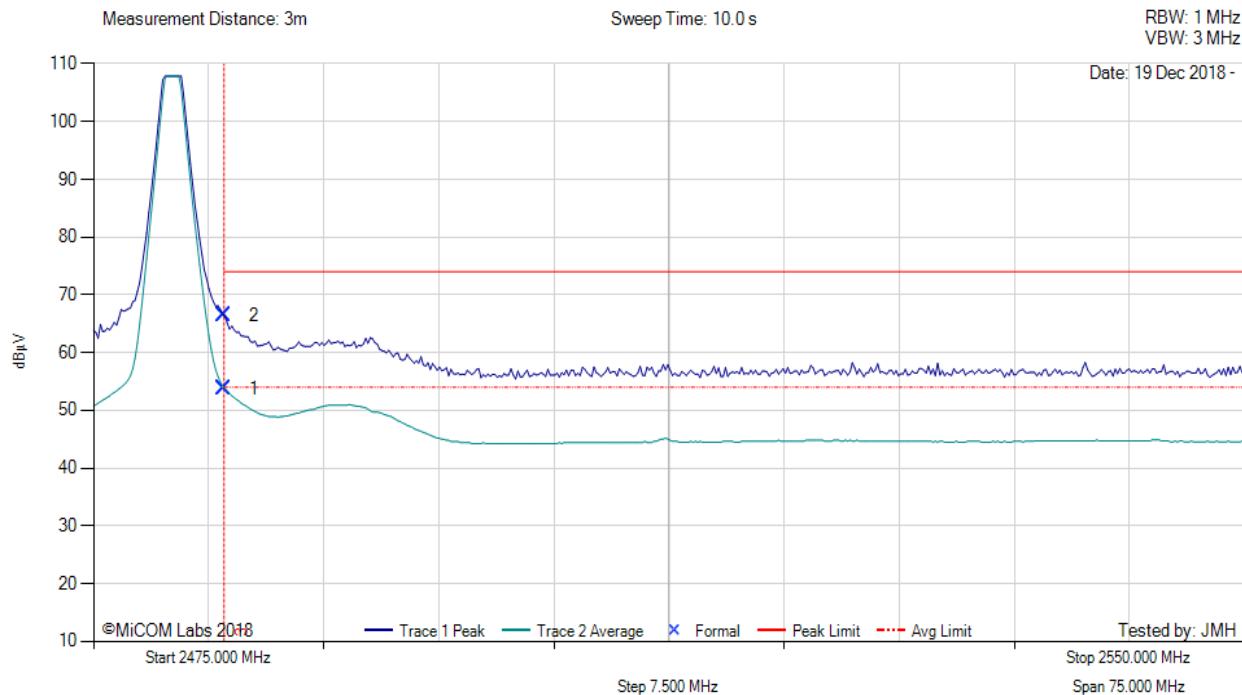
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RADIATED - UPPER RESTRICTED BAND-EDGE EMISSIONS

Variant: 1200 kbps, Test Freq: 2482.60 MHz, Antenna: WP WPANT30211-S1A, Power Setting: 15



2475.00 - 2550.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
1	2483.50	23.20	-1.78	32.33	53.75	Max Avg	Vertical	143	176	54.0	-0.3	Pass	
2	2483.50	35.83	-1.78	32.33	66.38	Max Peak	Vertical	143	176	74.0	-7.6	Pass	
3	2483.50	--	--	--	--	Restricted-Band	--	--	--	--	--	--	

Test Notes: EUT powered by DC Linear PS

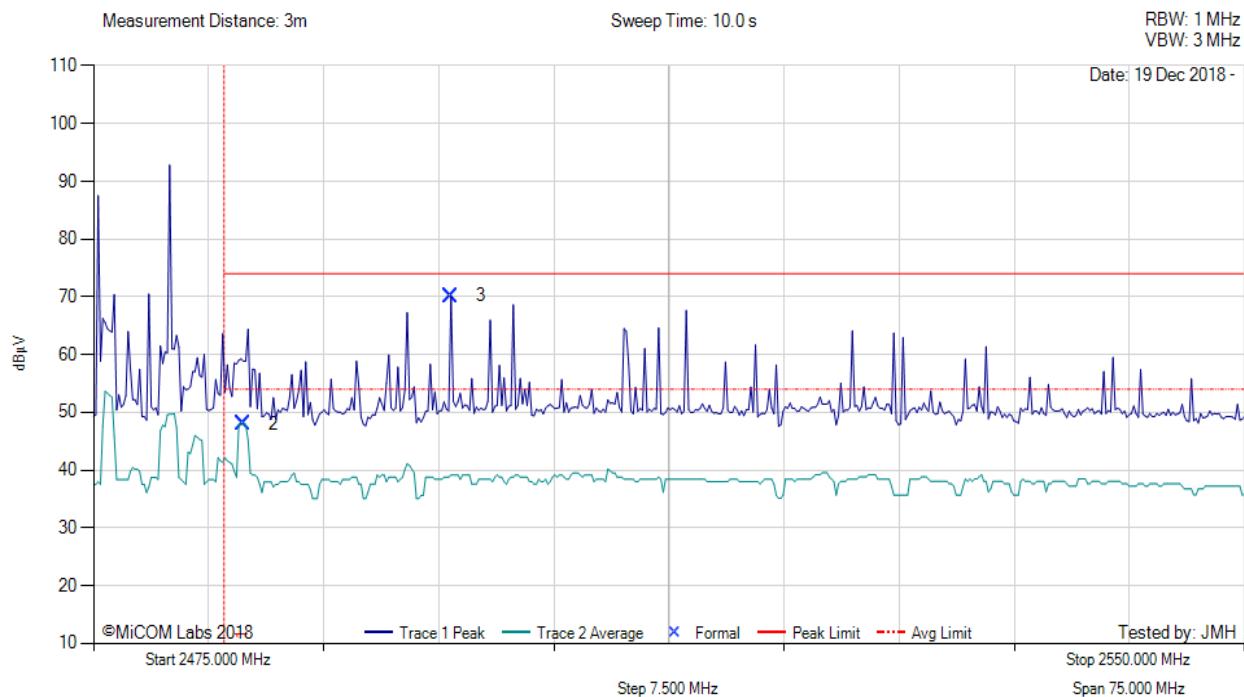
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RADIATED - UPPER RESTRICTED BAND-EDGE EMISSIONS

Variant: 2000 kbps, Test Freq: 0.00 MHz, Antenna: WP WPANT30211-S1A, Power Setting: 13



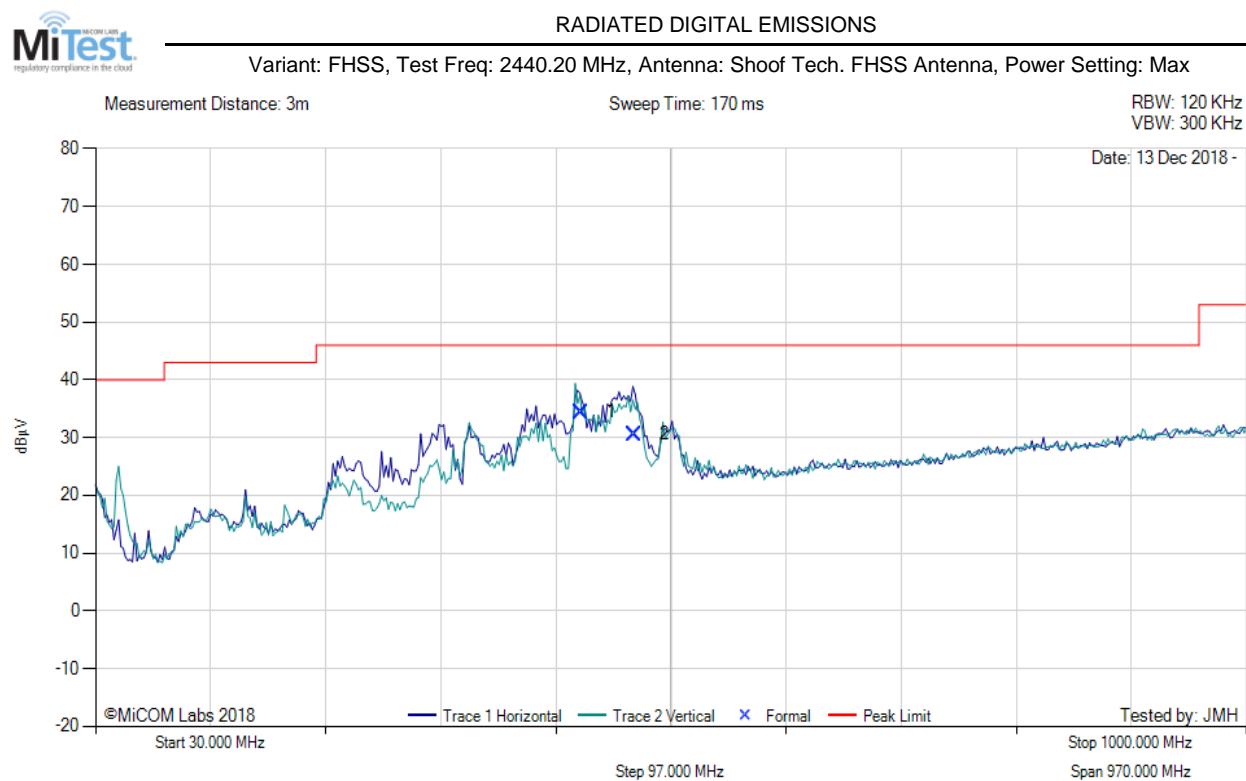
2475.00 - 2550.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
2	2484.77	17.38	-1.78	32.33	47.93	Max Avg	Vertical	143	176	54.0	-6.1	Pass	
3	2498.29	39.64	-1.77	32.32	70.19	Max Peak	Vertical	143	176	74.0	-3.8	Pass	
1	2483.50	--	--	--	--	Restricted-Band	--	--	--	--	--	--	

Test Notes: EUT powered by DC Linear PS. Hopping

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A.3.3. Digital Emissions



30.00 - 1000.00 MHz													
Num	Frequency MHz	Raw dB μ V	Cable Loss dB	AF dB/m	Level dB μ V/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dB μ V/m	Margin dB	Pass /Fail	
1	438.91	40.39	5.31	-11.30	34.40	MaxQP	Vertical	111	195	46.0	-11.6	Pass	
2	484.10	35.12	5.47	-10.00	30.59	MaxQP	Horizontal	101	156	46.0	-15.4	Pass	

Test Notes: EUT powered by DC Linear PS.

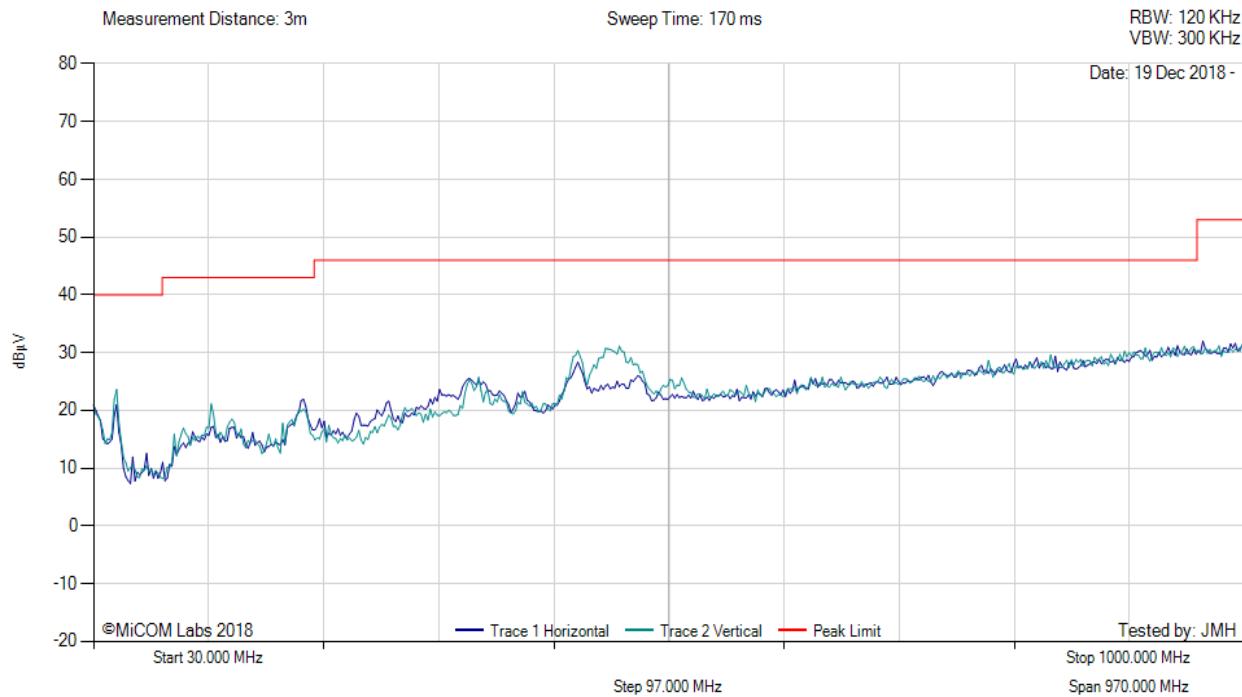
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RADIATED DIGITAL EMISSIONS

Variant: FHSS, Test Freq: 2440.20 MHz, Antenna: WP WPANT30211-S1A, Power Setting: Max



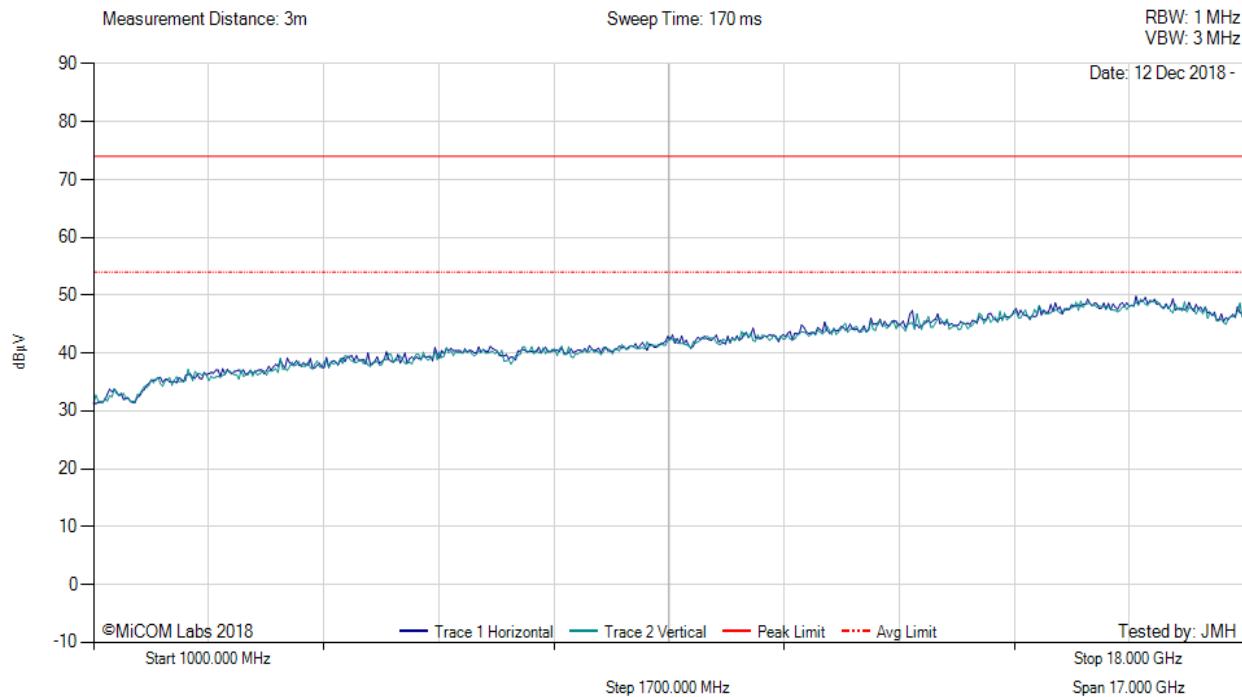
There are no emissions found within 6dB of the limit line.

Test Notes: EUT powered by DC Linear PS. Digital

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Variant: FHSS, Test Freq: NA, Power Setting: NA, Duty Cycle (%): NA



There are no emissions found within 6dB of the limit line.

Test Notes: EUT powered by DC linear PS. Receiver

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575 Boulder Court
Pleasanton, California 94566, USA
Tel: +1 (925) 462 0304
Fax: +1 (925) 462 0306
www.micomlabs.com